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REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART II.

LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
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REPORT UPON THE GENERAL SANITARY CIRCUMSTANCES OF THE MALTESE ISLANDS, WITH SPECIAL REFERENCE TO THE PREVALENCE OF MEDITERRANEAN FEVER THEREIN.

Part I.—General Sanitary Survey.

Part II.—Mediterranean Fever.

Part III.—Outbreak of Mediterranean Fever in the Essex Regiment.

Part IV.—General Summary and Conclusion.

By Dr. Ralph W. Johnstone, Medical Inspector Local Government Board.

Brief Description of the Maltese Islands.

These islands include Malta, Gozo, Comino, and Cominetto. The two latter are islets, and, save for the hospital for exotic disease on Comino, with its caretaker, are uninhabited.

The island of Malta is about 17 miles long by 8 wide, having an area of 91 square miles. At the census of 1901 the actually resident population was returned as 176,127. This includes a garrison of about 11,000 men. There were besides about the same number of men on the fleet who were not included.

Gozo is about 9 miles by 4½, with an area of 26 square miles. Its population was 20,002 in 1901.

Both islands are covered by low hills, which, with their intervening valleys, leave little or no flat surface. In Gozo the hills are more abrupt, but in neither island is the highest point more than 760 feet above sea level. Every available inch of land is cultivated, but the fields are shut in by high stone walls, which gives the country its characteristic stony and sterile appearance. There are no rivers.

Geologically the formation is an Upper Coralline limestone, under which are successive beds of greensand and marl, overlying a Globigerina limestone (often locally called calcareous sandstone), which again overlies a Lower Coralline limestone. Practically, all the inhabited part of Malta is denuded down to the Globigerina limestone, with occasional outcroppings of the Lower Coralline formation, and one or two patches of alluvium. The north-western and more elevated part of Malta is, however, covered by the Upper Coralline limestone, as is also the higher ground in Gozo.

PART I.—GENERAL SANITARY SURVEY OF THE MALTESE ISLANDS.

Density of Habitation.—The population enumerated on land at the census of 1901 showed an average density of 1671 persons to the square mile, or in Malta 1926 to the square mile, and in Gozo 775. The population was further classified into (*a*) persons living within the fortified towns—urban area, 55,298 persons to the square mile; (*b*) persons living close to the fortified towns—suburban area, 3976 persons to the square mile; and (*c*) persons living in the districts away from the fortified towns—rural area, 749 persons to the square mile. In Senglea, a part of the urban area, the density was as high as 183,932 persons per square mile, and in Sliema, part of the suburban area, 153,297. In addition, the greater part of the rural population in Malta is housed in villages where the density of population is often higher than in many English cities—Mellieha, for instance, has a density of 147,312 per square mile. Overcrowding of houses upon area is supplemented by overcrowding of persons in houses. Taking as a standard of overcrowding more than two persons living in one room in a tenement consisting of less than five rooms, there are 27 per cent. of the total number of persons in the Maltese islands who are living in overcrowded dwellings. (The percentage in England and Wales at the census of 1901 was 12·2.) This overcrowding is largely contributed to by the number of Kerreyas, or common lodging-houses which exist, especially in the fortified towns. In Valetta, with a total population of about 24,000 persons, more than 5000 persons live in Kerreyas. The population is rapidly increasing. In the decade 1892 to 1901 the Maltese-born population increased 11·6 per cent., other British subjects 12·5 per cent., and foreigners 37·1 per cent.; while each year the population around Valetta, and its harbours, especially tends to increase in density.

Dwellings.—All the dwellings are constructed of stone, generally in two storeys with a flat roof, which is utilised to collect rain-water. In the country districts window space is usually inadequate, sometimes, indeed, altogether absent. Owing to the porous nature of the local stone, the older dwellings, where the walls are not properly protected by copings and damp-proof courses, are said to be damp in winter. Most houses have a small yard or garden, in which is found the mouth of the underground tank used for storing rain-water from the roof. The pavement of the yards is nearly always porous, and is often cracked or defective near the tank mouth, where it is most used. The yard surfaces are very often strewn with refuse and the droppings of birds and animals, or soiled with slop water; they are usually drained to the street gutter. The flooring of rooms is generally constructed of porous stone, which forms a fine dust with surface wear. Rabbits, hens, cats, and dogs are kept in the houses, and sheep and cattle are housed in out-buildings, which usually abut on the dwelling-house.

Roads.—The roads are repaired by the Government, except a few which are repaired by the military authorities. Main roads are kept in good order, but owing to the friability of the local stone used as metalling, there is much dust. Bye-roads are often almost impracticable for wheeled vehicles. In the fortified towns scavenging is done by men in the employment of the Government, and surface water drains are provided. Outside the fortified towns street scavenging is neglected.

Excrement Disposal.—The method most generally employed is what is known as the hand-flushed water-closet. This closet is usually a long hopper basin with a syphon trap below, in connection with a cesspit or a sewer. The closet is, as a rule, used for emptying excrement and slops into. It is seldom used in any other way. It is placed in the most unexpected positions, sometimes in the open yard in a niche in the wall, frequently in the kitchen a foot or two from the cooking apparatus, or it may be in a small cupboard (1′ × 2′ usually) in the external wall of the house, or in the steps leading to the entrance hall from the front door, and sometimes even in the open street. It is very exceptionally found in a special room or in a position where it is likely to be used in the usual manner. In those poorer class houses which have got a special room for the water closet, the room serves often also as a larder or food store. The hand-flushing of these closets is conspicuous mainly by its absence. Water has always been a precious commodity in Malta, and is used sparingly; in addition cesspits are emptied at the owner's expense, at the high rate of 1*s.* 6*d.* per 100 gallons. The consequence is that one rarely sees a water-closet basin even moderately clean. They are usually caked with filth, and the surroundings fouled with fæcal matter. Again, when a poor proprietor owns a field or garden, he often ceases to make use of the closet, in order to avoid the cost of emptying, or because he values the excrement as manure. As result, the water in the trap evaporates, and cesspit or sewer air gains access to his premises.

The next most frequent method is what may be called the misbla system. A misbla is a dung heap, and it may be placed in the garden or yard, or more frequently in an outhouse adjoining the living rooms, or in an ordinary room in the house. Here all the excrement of the family is carefully preserved for removal to the fields. The abominable stench that may be caused in a dwelling by this system is not easily described. Occasionally a cellar is used as a misbla, and privy seats are placed in the room above. The vessels which are used to convey excrement from the bedrooms to its destination are often left in the house unemptied for several days. On one occasion on asking to see the vessel used for conveying excrement to the garden, I was shown the bucket in which the vegetables for the family dinner were being washed.

There are a few privy middens, and a few modern properly flushed water-closets. The garrison are provided with trough latrines, flushed once or twice a day, but owing to the feebleness of the flush and the defective pattern of latrine used, were often found overfull and offensive. In places where the latrines were flushed by a rush of water through the trough, a filthy and offensive residue was left behind after the flushing, and in places where the basins were flushed from above into the trough, the feeble trickle of water provided was entirely inadequate. The wooden seats of the military latrines are constructed a few inches above the iron surrounding the opening to the basin, with the result that urine is liable to soil the flat iron surface and dry there, after which the dried residue may be blown about by currents of air.

The naval latrines, or "heads," on board ship are of a better pattern, better flushed, and lack the iron cover underneath the wooden seat. The officers' water-closets, which are used also as urinals, are, from their height above the floor, peculiarly liable to contamination of the floors with urine.

Little effort is made to prevent the pollution of open spaces and walls by excrement and urine. The spaces around the landward fortifications of Floriana are especially liable to fouling, on account of the habits of the country people who pass every day into Valetta. Public urinals sometimes have no water supply, and thus become very offensive.

House Refuse Disposal.—There is no regular system for collection of house refuse in Malta. Certain men with carts call at the houses in the morning and take away house refuse for use as manure, but they are in no way bound to take it, and instances arise where they decline to remove refuse containing material not likely to be useful, such as tin cans and broken bottles. Ash-pits or bins are almost unknown. Refuse is thrown into the garden or into the street. Dead animals, vegetable refuse, and other filth may often be seen in the streets, and many complaints have been made by the better class inhabitants on this score. The police, however, seem powerless to enforce their regulations in the matter.

Owing to the lack of proper flushing the house drains and soil pipes become caked with filth, and complaints of smell arising from the inlet ventilators of house drains are frequent.

Sewers.—In some of the towns, for in Malta the villages are really small towns, quite compact and lacking in open spaces, there are sewers which have existed for centuries. They are built of, or cut in the porous rock, being more in the nature of galleries than sewers, and they are not in any way rendered impervious. They act as elongated cesspools where the liquid sewage gradually soaks away into the rock, leaving a semi-solid residue. Such, for instance, is the system at Birchirchara, Victoria, and formerly at Curmi.

Modern sewers exist at Valetta, Cospicua, Senglea, Vittoriosa, Calcara, Misida, Curmi, and Sliema, and are in course of construction at Notabile and Rabato, and at Hamrun. Many of the houses abutting on the harbour still drain into it, so that when the fleet is in, and many ships are discharging their sewage into the Grand Harbour, the water is liable to become visibly polluted with excremental matter. Since there is very little tide, this may become a serious nuisance.

Cesspits, in the case of new houses, are built under the street and are ventilated and cemented. In the old houses the cesspits are often under the dwelling rooms and unventilated. Very frequently they are placed close to the water tanks. Many old cesspits are never emptied, since they are not impervious, and it is to be feared that new cesspits are occasionally tampered with so as to render them pervious, after they have been passed by the sanitary authority. Cesspits are emptied by means of a pumping engine into iron tank carts. The contractor who undertakes this work is empowered to charge at the rate of 1*s.* 6*d.* per 100 gallons.

Water Supply.—There is a public water supply laid on to every village in Malta except Mellieha. The water is derived from groups of springs in three different localities, which afford an approximate mean daily yield of 418,500 gallons by gravity. In addition, there are three other sources from which potable water is pumped, the mean daily yield being about 693,000 gallons. Besides the drinking water there is a brackish water found at Armier, and pumped to Valetta, where it is used for watering streets and flushing sewers. The main storage reservoirs for drinking water are at Ta Kali, near Attard, and are capable of holding 16,865,200 gallons. The total storage capacity of the island is 18,980,000 gallons. The gathering grounds for the water supply are for the main part in thinly populated portions of the island. The water is collected in galleries driven in the rock deep below the surface, and conveyed by iron pipes to the tank or pumping station. From there it is distributed by cast-iron pipes or by stone channels built in, and lined with cement. The water is usually distributed by means of stand-pipes in the villages. In Valetta the houses generally have taps, but they are often without them, and outside the area surrounding the harbours taps are seldom found in the houses. In some villages there are large underground tanks provided by the roadside, which are filled in the winter from the public water supply. These tanks are seldom fitted with pumps, and in consequence become very foul from the constant lowering into them of buckets which have been allowed to stand on the roadside. The vicinity of pervious cesspools provides a possibility of pollution which is often present.

Practically every house in Malta has underneath it a large tank for collecting rain-water from the roof. This water is generally preferred to the public water supply for drinking, possibly because it is cooler in summer. The contents of these tanks very often show signs of pollution, nor can this be wondered at when it is considered that the roof is very much used by the family in summer, and by their cats and dogs. Tanks are never supplied with pumps, and the bucket which is lowered into them by a rope is often placed on the yard flags amidst slop water and pollutions due to animals or to the neighbouring water-closet. There are very few wells in Malta.

In Gozo the public water supply is obtained from similar sources to that of Malta, the total mean daily supply amounting to about 143,000 gallons, derived from three principal sources. About 90,000 gallons of this water, coming from two sources, is brackish, and about 50,000 gallons, coming from the other source, is good water. The two qualities are mixed before distribution, and the result is a water containing considerable quantities of magnesium salts, which is liable to affect new comers prejudicially.

In the villages of Xahra and Nadur there are wells, a few also being found in Victoria; but elsewhere the usual rain-water tank system prevails, and is liable to the same dangers as in Malta.

All the villages in Gozo except Xahra, Zebbug, Nadur, and Kala have the public water supply, and Nadur is about to be supplied.

Hospitals.—There is a hospital for infectious diseases in connection with the Lazaretto on Manoel Island. It is intended for the isolation of small-pox, scarlet fever, diphtheria, and erysipelas. The buildings are out of date.

The Central General Hospital is at Floriana. It has 226 beds, including the Seamen's Hospital, which adjoins it. It receives cases of enteric and Mediterranean Fever, besides surgical and other cases. No attempt is made to isolate the Mediterranean Fever cases from the others. The methods of this hospital in the matter of cleansing the patient and disposal of the contents of bed-pans of enteric and Mediterranean patients are unsatisfactory. Reference will be made to this matter later. There is no proper hospital sink, and the laundry is inadequate. All infected clothing is despatched to the poor-house laundry. It is said to be steeped in corrosive sublimate solution before being sent, but I saw no signs of the process at my visit, except some barrels containing water, which were shown me as the receptacles used for steeping. There is a general hospital at Citta Vecchia, known as the Santo Spirito Hospital, containing some 70 beds, and there is a similar institution in Victoria, Gozo, with about 60 beds.

The quarantine hospital on the island of Comino is well isolated. It is intended only for ship-borne cholera, yellow fever, or plague.

There is a large building at Marfa, well isolated, which is intended to serve for cases of exotic disease amongst the inhabitants of Malta.

The military hospitals are seven, six in Malta and one in Gozo. The Station Hospital, Valetta, accommodating about 200 patients, is the ancient hospital of the Knights of St. John. The building is unsuitable for a modern hospital. It contains no hospital sink. Attached to it is the hospital of the Royal Malta Artillery.

The Royal Naval Hospital at Bighi contains about 200 beds.

Sanitary Administration.—There is a Council of Health, consisting of twenty members, six of whom are medical men. It is their duty to advise the Government on sanitary regulations, on quarantine measures, on public works in connection with hygiene, including drainage and water supply, and on all other matters of public health. The Council has power to suggest measures, inquiries, and scientific investigations in connection with public health. The Council meets every two months.

The public health department is directed by the Superintendent of Public Health, Mr. R. P. Samut, M.R.C.S. Eng., who receives £400 per annum. It is his duty to watch over and direct the medical officers of health, the sanitary inspectors, and all other officers of the department, and to advise them. He has also to inspect at intervals the hospitals, quarantine establishments, slaughter-houses, charitable institutions, prisons, etc. Finally, he has to advise the Governor, when required, on public health questions, and he has to draw up an annual report on the sanitary state of the islands, and send it to the Governor.

The Superintendent of Public Health thus reports direct to the Governor, and the functions of the Council of Health are purely advisory, or at most suggestive. The Superintendent solely is responsible for the annual report. His position is one of great responsibility, demanding experience and a high degree of expert knowledge.

There are two medical officers of health for Malta—Dr. Caruana Xicluna, who receives £350 a year, and Dr. F. Xuereb, who receives £250. These gentlemen divide their duties—the first-named superintending buildings, zymotic diseases, foods, shops, and noxious trades, while the latter looks after drainage, notifications, isolation, disinfection, and overcrowding.

There is a medical officer of health for Gozo—Dr. E. Calleja, who receives £120 a year. The Sanitary Engineer, Mr. C. Mallia, receives £170, with £30 additional as superintendent of drains. There are 18 sanitary inspectors in Malta, receiving about £60 a year each. In Gozo there are four, who receive salaries on the same scale. There is an inspector of markets, who receives £110 a year; Mr. MacFarlane, M.R.C.V.S., who superintends the slaughter-house, receiving £30 a year.

There are 22 district medical officers in Malta, and four in Gozo. Up to 1885 these officers received £10 a year for certain public health duties; but since then each of them receives a lump sum varying from £60 a year to £140 a year to cover all their duties, which are in the main the same as those of our poor-law district medical officers. They also perform vaccination twice a year free of cost. Their public health duties are to inspect infected premises, and determine whether the patient must be removed to hospital or not; to inspect bad food if called in by a sanitary inspector, and to inspect midwives once a month, and see that their equipment is adequate and clean.

The district medical officers are under the control of the Comptroller of Charitable Institutions, as are also the hospitals and other charitable institutions.

There is a public analyst and bacteriologist, with two assistants. Dr. T. Zammit has held the post since January, 1891.

The annual report of the public health department has of late years been very disappointing. Formerly it contained comments and suggestions, but it is now merely statistical and conveys little information as to the conditions which exist and have to be dealt with by the department.

Some of the sanitary inspectors are hard-working, intelligent men, who know their districts; but not a few are entirely ignorant of the elements of sanitation, and in some cases even of the conditions prevailing in their districts. Close supervision and drastic weeding out is required amongst them. The Government have made a new departure this year in sending three young men to England to be trained as sanitary inspectors. They are to be followed by others if the experiment prove successful. I have great hopes that it will. Some of the sanitary inspectors make house-to-house inspections daily, but others never do so unless a case of infectious disease arise. The poorer people are too ignorant of sanitation to make complaint, so that without frequent inspection grave conditions may be allowed to exist for long periods. The public health department have issued a general order to the sanitary inspectors not to report faults in drainage unless urgent, on the grounds, I was informed, that all the villages would some day be sewered. The order is liberally interpreted by many of the inspectors, and was quoted to me in extenuation of such conditions as cesspits ventilated into living rooms, sewers ventilated into houses by unsealed water-closets, leaky cesspits, etc.

There is a sanitary commission appointed by the Governor for the maintenance and construction of drainage. The Superintendent of Public Works is chairman, and there are six other members, four of whom are medical men.

Notification of Infectious Disease.—There is no payment for notification, and though there is a penalty for neglect to notify, it is difficult to exact, and in point of fact never has been exacted. Many considerations interfere with the accurate notification of Mediterranean Fever. For instance, persons who die of it are not permitted burial in a church, a cherished privilege outside the fortified towns, or a private practitioner wishes to spare his patient the annoyance and expense of lime-washing and disinfection. In addition, the diagnosis is often difficult, the serum test not generally being applied. The consequence is, only severe cases are notified, and not always these. In the official record of the notifications, the age and sex of the patient is generally unrecorded; in many instances even the name is not recorded, nor the number of the house.

A Maltese medical man of experience told me he did not think more than a third of the cases of Mediterranean Fever that occurred in Malta were notified, and not more than a fifth of those in Gozo. I think this estimate is not far wrong. In addition, I found that many English cases attended by Army doctors were not notified.

The following diseases are notifiable:—Plague, cholera, yellow fever, small-pox, scarlet fever, diphtheria, diphtheritic croup, typhus fever, enteric fever, measles, remittent fever (Mediterranean), febrile puerperal diseases, continued fever (on 7th day), erysipelas, epidemic spinal meningitis, chicken-pox, influenza, whooping cough.

Disinfection.—The usual means adopted are fumigation by burning sulphur, soaking washable materials in corrosive sublimate solution, and lime-washing. Bedding and other articles unsuitable for soaking are not sent to the steam disinfector in cases of Mediterranean Fever, seldom indeed in any disease.

Isolation.—Small-pox and diphtheria are isolated, and the early cases in outbreaks of measles or scarlet fever. The routine adopted in these diseases is as follows:—The case is visited by the District Medical Officer, who reports whether it can be isolated at home or not. If it can be isolated at home, a man is sent to act as health guard, whose business it is to prevent communication between the sick room and the public. If the case has to be removed, a police sergeant is sent with the ambulance.

Mediterranean Fever is not isolated.

Sanitary Law is embodied in ordinances enacted by the Governor with the advice and consent of the Council of Government. They cover much the same ground as our own public health laws, though some of the Maltese ordinances are more stringent. They include regulations as to noxious trades, bake-houses, milk-shops,* buildings, markets, refuse in streets, etc.†

There is a quarantine medical officer, with three assistant medical officers, and a veterinary surgeon.

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* The usual source of milk in Malta is the goat. These animals are driven about the streets in flocks, and are milked at the customer's door into his own vessel. The udders, which are abnormally large, often touching the ground, are very liable to be soiled. The proprietors of herds are so many that it is always difficult to ascertain from a householder where he has got his milk. No regulations are in force for the effectual control of these vendors.

† The regulation against throwing refuse and offal into the streets is not enforced, or very feebly so.

PART II.—MEDITERRANEAN FEVER.

Introductory.—I do not propose in this report to deal with the history and literature of Mediterranean Fever, or with its symptoms, treatment, or distribution outside Malta, except very briefly, and in so far as these have a direct bearing upon my own part of the work of the Commission.

The study of Mediterranean Fever, virtually commenced by Marston's paper in 1861, received its great impetus from the discovery of the *Micrococcus melitensis* by Bruce in 1887. After this, for many years the difficulty of diagnosis caused by the strong resemblance between this fever and other diseases endemic in Malta, such as enteric fever and the fever known as "simple continued," retarded investigation and detracted from the value of the figures recorded.

In 1897, Wright and Semple, by introducing the serum agglutination test, placed matters on a more exact basis. This method was in 1900 adopted as a routine practice in the Army, and shortly after in the Navy.

Since the publication of Hughes' book in 1897, Mediterranean Fever has attracted considerable attention in the Army and Navy, and much has been written about it. With the exception of Zammit's paper in 1902, little appears to have been done in the way of studying its behaviour amongst the civil population of Malta, either by the local medical men or by others. It was partly for this reason that I devoted most of my attention, during my stay in Malta, to the disease as it occurred amongst the Maltese.

From the outset I found myself confronted by two difficulties, the first, a badly administered system of notification, which has been already referred to in Part I of this report, and closely allied with it considerable unreliability of diagnosis, due partly to the fact that the serum agglutination test is not generally in use in Malta outside the Army and Navy, in spite of the facilities afforded by the Bacteriological Laboratory at Valetta. My second difficulty was the fact that very few Maltese speak English, and that their natural politeness leads them generally to try and give the reply they deem most likely to please, and not that which is most strictly in accordance with the facts. Add to this a strong distrust of the sanitary authority, whose objects they are in general unable to understand, and whose visits they regard solely as a probable source of expense to themselves in the way of white-washing or cleansing, and it will be understood that accurate information was not always easy to come by.

The Geographical Distribution of Malta Fever will be of importance in the future study of the conditions which favour the spread of the disease.

The following list of places, from which Mediterranean Fever has been reported, is taken, with slight additions, from the "Journal of the R.A.M.C.," vol. ii, No. 4:—*Spain*—Gibraltar; *Islands of the Mediterranean*—Balearic Islands, Corsica, Sardinia, Sicily, Malta, Gozo, Cyprus, Crete; *Italy*—Rome, Naples, Caserta, Benevento, Campobosso, Aricca, Terano, Fermo, Padua, Cittanova, etc.; *Greece*—Athens, Cephalonia; *Turkey*—Constantinople, Smyrna; *Palestine*—Jerusalem; *Africa*—Tunis, Algiers, Alexandria, Suakin, Massowah, Zanzibar, Kimberley (?); Aden; *India*—Calcutta, Mian-Mir, Nowshera, Secunderabad, Simla, Delhi, Lucknow, Agra, Allahabad, Choabattia, Subatha, Assam, Swat Valley; *China*—Hong-Kong, Philippine Islands, Fiji Islands; *North America*—Mississippi Valley; *West Indies*—Cuba, Puerto Rico; *South America*—Venezuela, Brazil, Montevideo.

This list will probably undergo considerable enlargement and alteration in the future, and I will only say in connection with it that there are factors which I am not in a position to take into account, such as the reliability of the diagnosis or of the cultures by means of which the diagnosis has been confirmed, and the fixing of the place where infection took place, having regard to the prolonged liability to relapse.

Hitherto, Mediterranean Fever has not been reported north of the 45th parallel or south of the 40th.

Incubation Period.—The general impression amongst Maltese medical men seems to be that the usual incubation period of Mediterranean Fever is not more than 8 or 10 days.

The following cases have occurred in the course of laboratory work with the *Micrococcus melitensis* in places where there was no prevalence of Mediterranean Fever and no apparent source of infection other than in relation with infective material in the laboratory:—

	Incubation period.
1.—S. From an accidental prick with a syringe needle which contained a living culture	15 days
2.—W. From purposeful hypodermic injection of a living culture	16 ,,
3.—B.S. From accidentally drawing into the mouth a small quantity of living culture through the mouth......	8 ,,
4.—E. From the same kind of accident as 3	6 ,,
5.—S. From accidental wound of the conjunctiva with a portion of a broken tube which had contained living culture*...	5 ,,

Besides the above, Fleet-Surgeon Bassett-Smith has informed me of another laboratory case in which the occasion of inoculation could not be traced.

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* In this case, examination by an oculist, soon after the breakage of the tube, failed to disclose any wound of the conjunctiva.

The five cases given above are too few to afford sufficient basis for trustworthy induction. They are, moreover, open to the objection that infection did not necessarily take place on the occasions cited, but may have occurred at some other time in the course of work with infective material. But after due allowance made for the latter consideration, No. 2 is to be regarded as of materially greater value as a guide to the incubation period of Mediterranean Fever than any of the others, since, in this instance, there was a definite and purposeful introduction into the system of a presumably sufficient amount of living culture of *Micrococcus melitensis*, accompanied by record of the time of such introduction, and by subsequent outlook for the first appearance of illness. The remaining four cases, which are marked by considerable diversity in respect of the incubation periods inferred, are more open to challenge, and, therefore, afford less trustworthy guidance in this matter than does No. 2.

I have made inquiry with a view to finding how many cases of Mediterranean Fever have been observed to occur on board our ships of war after leaving a Mediterranean port and before touching at another Mediterranean port.

Fleet-Surgeon Bassett-Smith has kindly examined his records and sent me 13 cases which occurred on board ship, but none in which it could be confidently said that the fever occurred more than 14 days after leaving the last Mediterranean port of call. He included three cases in which Mediterranean Fever occurred three weeks after the ship left Malta, but he was unable to say she had not subsequently called at a Mediterranean port before the onset of the fever. He also included a case in which Mediterranean Fever occurred 12 months after leaving the Mediterranean, but said that the patient had a slight attack of fever while on the Mediterranean station, so that the possibility of a relapse cannot be excluded.

Fleet-Surgeon Bassett-Smith also sent me the following remarkable case:—A. B. left Gibraltar December 20, 1903, having had no attack of fever at the time and feeling quite well. He arrived home for Christmas, went on leave for a month, and then took on duty attached to the "Excellent" gunnery establishment at Gosport. About February 20, 1904, acute fever set in, for which he was sent to the Royal Naval Hospital, Haslar, as a case of enteric fever. His blood was examined in the first fortnight, and gave a negative reaction for enteric, but a positive for Mediterranean, and later on the *Micrococcus melitensis* was isolated from his blood. This case must have had an incubation period of two months if it be conceded that infection occurred in the Mediterranean. There is the possibility that he was infected from some unrecognised case at Gosport, but this possibility is largely discounted by the fact that many cases of Mediterranean Fever are annually treated at the Royal Naval Hospital, Haslar, without any recorded spread of infection. The case, though exceedingly interesting, will be of greater value in the consideration of the incubation period of Mediterranean Fever, should other like cases occur hereafter; at present it stands alone.

From Staff-Surgeon Gilmour I received record of eight cases which occurred on warships at sea, and two others I saw myself in Malta, but none of them occurred more than 14 days after the ship had touched at a Mediterranean port.

Ships while on the Mediterranean station are seldom or never more than a few days without touching at a port, so that their records are unlikely to afford any guidance until they leave the station for home.

I received from Lieutenant-Colonel Rhodes, R.A.M.C., details of a search which he caused to be made, at my request, in the records of the R.A.M.C. at Malta for the period January 1, 1901, to August 31, 1904. During that time only two cases could be found in which Mediterranean Fever had occurred less than 14 days after the patient's arrival in Malta. The first case was a Munster Fusilier, who was admitted to hospital suffering from Mediterranean Fever on February 22, 1901, eight days after the regiment's arrival in Malta, from England. The second case occurred in the Sussex Regiment, and was admitted to hospital on July 7, 1904, 11 days after the regiment's arrival in Malta, from England.

Further evidence is required before a definite average incubation period can be established. It may, however, be provisionally stated that the data available tend, in some degree, to suggest that the incubation of Mediterranean Fever ranges about a period of 14 days.*

Distribution of Mediterranean Fever in the Maltese Islands.

Mediterranean Fever occurs in every part of Malta and Gozo, on the sea coast and inland, though as a rule its relative incidence is less severe in the villages more remote from the capitals.

The figures given below with regard to cases have been abstracted from the civil official notification returns, where Mediterranean Fever is generally notified under the name of remittent fever. There are in these returns numerous cases notified under the name continuous fever. These Zammit has included in his returns as Mediterranean Fever cases. His grounds are that in Malta all fevers lasting more than a week are notifiable by law, and since all the named fevers—

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* Bruce says that cases have occurred in as short a time as 6 days after arrival in Malta. Hughes, while stating his belief that the incubation period is sometimes as short as 3 days, considered that 10 to 15 days is the most usual time.

such as enteric, etc., are notified separately under their proper headings, the residue returned as continuous fever are in reality Mediterranean Fever. He does not, however, reckon with the fever known as "simple continued fever," the most common form of illness in Malta during the hot weather, or else he does not consider that simple continued fever commonly lasts more than a week.

I have examined the records of the naval hospital in Malta, where the diagnosis is at least as careful as in Malta generally, and I find that during the five years 1897 to 1901 the average duration of cases returned under the heading "Other Continuous Fevers" is over eight days. Practically, all these cases must have been "simple continued fever," since Mediterranean Fever, enteric, malaria, and other named fevers are placed under separate headings. I think it, then, more probable that the majority of the cases noted in the Maltese notification returns as continuous fever were cases of "simple continued fever" than that they were cases of Mediterranean Fever. I have, therefore, included in tables dealing with cases of Mediterranean Fever only those cases which were entered in the Maltese notification records as remittent fever, or as Mediterranean Fever.

Table I (pp. 18 and 19) shows the number of cases of Mediterranean Fever which occurred in each of the districts of Malta and Gozo amongst the civil population during each year of the period 1894 to 1903, together with the mean estimated population of each district during the same period, the average number of cases of Mediterranean Fever per 10,000 of population per year, and the number of deaths from Mediterranean Fever during the whole period.

The very general distribution of Mediterranean Fever throughout Malta is perhaps the most striking feature of this table. It will be seen, too, that it is by no means the localities closest to the harbours which suffer the most severely. Hamrun, a somewhat squalid suburb, and the combined villages of Lia, Attard, and Balzan show the heaviest incidence, while Valetta and the three fortified towns, Cospicua, Senglea, and Vittoriosa, are amongst the least severely attacked. In some respects, however, the latter four places cannot fairly be compared with the remainder of the island. All four towns are paved, drained, and scavenged, a state of affairs not found in any other part of the island.*

Disregarding Valetta and the three fortified towns above mentioned, it will be found that the severity of incidence in Malta depends roughly on the amount of the population. The average incidence throughout

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* Floriana is drained but not paved, and the scavenging is not so well carried out as in Valetta; moreover, a vast number of country people pass through it each morning to reach Valetta, and complaints have been made that they use the fortifications around Floriana as a latrine. Curmi was sewered in 1901, Sliema in 1902, and Misida and St. Julians in 1903.

Malta as a whole, is 32 cases per year per 10,000 of population, and the average for places other than the four towns first mentioned is 37·8, neglecting the cases which occurred in public institutions. The average number of inhabitants for each of these places is 4240. Twelve of them contain more than 4240 persons each, and in 8 of the 12 the average incidence is greater than 37·8. Fourteen districts have less than 4240 inhabitants, and in 12 of them the average incidence is less than 37·8 per 10,000. The mean incidence on the group with over 4240 population is 41·6 per year per 10,000 during the 10-year period, while that upon the group with less than 4240 population was for the same period 26·7 per year per 10,000. This is no doubt a very rough classification, and there are notable exceptions, such as Curmi. On the other hand, the notification returns dealt with are not sufficiently reliable to justify any but the most general groupings, perhaps not even these. The classification, such as it is, would tend to show that, outside Valetta and the towns named, the greater the aggregation of inhabitants living in one locality, the greater is the proportional number of cases of Mediterranean Fever that occurs amongst them. The returns from Gozo do not show the same result, but then the numbers dealt with are smaller and the returns themselves probably more inaccurate than in Malta.

Density of population upon area outside Valetta, Cospicua, Vittoriosa, and Senglea appears to have some influence on the incidence of Mediterranean Fever. Floriana, Hamrun, Misida and Pietá, Sliema, Zeitun, and Mellieha are the most densely populated, all having more than 100,000 persons to the square mile. With the exception of Mellieha, and in a lesser degree Zeitun, these places all have a case incidence above the average. On the other hand Zebbug, Siggeui, Axiak, Gudia, Chircop, Safi, Zurrico, and Krendi are the least densely populated, each having less than 30,000 persons per square mile, and the proportional incidence on all these places, except Zebbug, is less than the average.*

For purposes of comparison, it has been customary for some years past to divide Malta into three areas—(1) *an urban drained area*, comprising Valetta, Floriana, Cospicua, Vittoriosa, and Senglea; (2) *a suburban undrained area*, comprising Misida, Pietá, Sliema, St. Julian's, Hamrun, Birchirchara, Curmi, Zabbar, Tarxien, and Paola; and (3) *a rural area*. Comparing the three areas for the period 1894 to 1903, it appears that the average number of cases of Mediterranean Fever per year per 10,000 inhabitants was—

(1) Urban drained area	18·8
(2) Suburban undrained area	41·8
(3) Rural area	33·4

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* It will be seen later, when considering the maps, that density of population upon area in parts of districts, does not show the same influence.

Table I.

—	Number of cases of Mediterranean Fever notified.											Mean estimated population during the period 1894–1903.	Average number of cases of Mediterranean Fever per year per 10,000 of mean estimated population during the period 1894–1903.	Number of deaths from Mediterranean Fever during the period 1894–1903.
	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	Total.			
Malta—														
Valetta	17	16	52	22	25	39	44	49	46	30	340	23,052	14 ·3	53
Floriana............	16	7	34	28	18	43	31	28	27	38	270	5,910	45 ·7	20
Misida and Pietá....	5	1	3	20	19	26	21	24	60	29	208	3,648	57 ·1	6
Sliema and St. Julian's	44	24	53	57	33	55	43	42	67	52	470	10,856	43 ·3	39
Hamrun	4	38	71	86	73	92	81	104	34	24	607	9,364	64 ·8	26
Cospicua...........	6	3	74	27	12	16	9	21	8	25	201	12,128	16 ·6	31
Vittoriosa..........	1	6	7	13	37	33	26	14	13	14	164	7,162	22 ·9	16
Senglea	—	1	30	14	11	7	2	4	8	7	84	8,012	10 ·5	10
Notabile and Rabato.	14	5	8	17	32	76	14	16	36	25	243	8,045	30 ·2	36
Dingli	—	—	—	—	—	4	7	3	16	—	30	759	39 ·5	2
Zebbug	3	24	53	17	18	13	68	19	28	47	290	5,416	53 ·5	21
Siggeui.............	2	—	4	10	16	33	8	3	6	4	86	3,192	26 ·9	9
Birchirchara........	10	28	30	25	37	103	67	58	41	42	441	8,144	54 ·2	42
Lia, Attard, and Balzan..............	38	27	58	19	12	52	25	35	31	33	330	4,522	73 ·0	20

Naxaro	6	6	6	15	4	16	11	21	10	14	109	3,443	31 ·7	6
Musta	5	3	12	3	32	27	34	24	27	24	191	4,675	40 ·9	27
Gargur	—	—	—	10	—	3	7	1	6	4	31	1,355	22 ·9	5
Mellicha	—	—	3	—	5	2	7	5	3	1	26	2,233	11 ·6	4
Curmi	2	—	1	2	4	3	5	17	8	6	48	7,994	6 ·0	9
Luca	—	—	1	—	2	—	3	2	6	12	26	3,318	7 ·8	5
Tarxien and Paola...	6	7	7	8	5	16	3	8	24	17	101	4,476	22 ·6	15
Zurrico	6	3	13	11	12	22	8	4	5	3	87	3,589	24 ·2	8
Safi............	—	2	2	2	—	2	—	1	2	2	11	350	31 ·4	1
Krendi............	1	—	7	7	6	5	1	1	1	—	31	1,559	19 ·9	5
Micabiba............	1	1	10	3	2	2	—	—	2	2	23	1,192	19 ·3	1
Chircop............	—	3	2	—	3	1	1	1	1	2	14	619	22 ·6	1
Zeitun............	55	14	31	44	10	8	17	14	7	22	222	7,492	29 ·8	12
Zabbar............	47	7	29	18	17	18	14	24	13	27	214	5,549	38 ·6	20
Axiak	9	3	5	1	2	1	4	6	1	1	33	1,493	22 ·1	1
Gudia	3	2	9	3	2	3	4	—	—	4	30	1,141	26 ·3	1
Public institutions...	9	16	15	13	6	27	43	23	14	7	173			
Total	310	247	630	495	455	748	608	572	551	518	5134	160,603	32 ·0	452
Gozo—														
Victoria............	4	11	12	4	9	10	2	6	—	13	71	6,101	11 ·1	3
Garbo	—	—	1	—	—	1	3	—	—	—	5	1,708	2 ·9	5
Zebbug	—	—	—	—	1	2	—	—	1	1	5	1,166	4 ·3	—
Sannat............	—	—	—	2	7	7	8	—	—	1	25	1,093	22 ·9	4
Xahra	3	2	2	51	28	18	22	13	5	2	146	2,509	58 ·2	7
Xeuchia	—	—	—	10	6	2	2	7	7	9	43	1,718	25 ·0	2
Nadur and Kala	2	1	—	1	—	3	1	24	14	7	53	4,079	13 ·0	7
Ghainsielem	—	—	2	—	1	1	—	3	10	1	18	1,106	16 ·3	2
Ospizio	—	1	—	—	—	5	2	—	—	1	9			
Total	9	5	17	68	52	49	40	53	37	35	375	19,480	19 ·2	30

Considerably below the average number of cases occur in the urban area, and considerably above the average in the suburban area, while the rural area suffers in much the same degree as Malta taken as a whole.

The urban area is better drained and paved, scavenging is more efficiently carried out, and it has more public conveniences than other parts of the island. On the other hand, there is in the urban area equal or greater aggregation of persons in one locality, and more overcrowding upon area. There is no marked difference between the urban and suburban areas as a whole in the matter of the wealth and station of their inhabitants. Parts of Valetta such as the Manderaggio contain the very poorest of the population, and these parts do not appear to suffer out of proportion to their numbers. The three cities also have many very poor inhabitants; but Sliema and St. Julian's are probably the most wealthy and fashionable parts of the island.

There are some stumbling blocks in the way of all attempts to generalise from the table above. The most striking is the difference in the incidence upon Curmi and upon Birchirchara. These two towns, for they are really small towns rather than villages, are situated close together, on the same kind of soil, with the exception that a part of Curmi is on alluvial soil. They contain about the same number of inhabitants, and the same kind of houses, any difference being that there are more good houses in Birchirchara, yet the incidence of Mediterranean Fever upon the latter has been nine-fold as great as upon Curmi during the period 1894 to 1903. I have examined these villages from many points of view, but I have hitherto found nothing that would account to my mind for the difference. It may be that the personal factor is of unusual weight here in the matter of notification. I hope, however, to have some more facts to consider in this connection when the returns which are now being collected in Malta are due for examination.

I prepared a map for the purpose of studying the distribution of Mediterranean Fever during the period January 1, 1899 to July 31, 1904, in Valetta and Floriana respectively.

In Valetta there is no marked aggregation of cases in proportion to population. The apparent aggregations of cases in the Manderaggio, in Strada S. Giuseppe, and in Str. Pozzi are due simply to the fact that these localities are very thickly populated, consisting mainly of houses each of which contains many families—"Kerreyas" or common lodging-houses. I was informed, for instance, that about 3000 people live in the Manderaggio.

In Floriana, also, most of the groupings of cases are due to cases occurring in different families living in the same "Kerreya." There is, however, a remarkable immunity from attack noticeable in Piazza

Maggiore, Piazza Britannica, and Strada Giardino, all of which face on to broad open spaces, and consist in the main of better class houses. This may be partly explained by the fact that the English doctors do not as a rule comply with the notification law. Most better class streets in Floriana, Sliema, and St. Julian's are occupied to a considerable extent by English people, who are generally attended by English doctors.

Another map showed the distribution of Mediterranean Fever in Hamrun during the period January 1, 1892 to July 31, 1904. Here there are not so many "Kerreyas," and in consequence there is less apparent grouping of cases than in Valetta and Floriana.

A third map showed the distribution of cases during the same period in Sliema. Mediterranean Fever cases here show a distinct preference for the southerly slope towards Sliema Creek as opposed to the northern slope towards the open sea, and the houses in Strada It-Torri, which face the sea, seem to have escaped attack. But many of these houses are occupied by English people, and in any case the streets running down to Sliema Creek are much more densely inhabited.

My maps of Misida and Pietá proved valueless, because the notification returns left so many houses unindicated, the names of the streets only being given.

The other maps in my possession serve only to show the same lack of definite aggregation of cases around a particular centre.

The following table shows the distribution of Mediterranean Fever during the period 1901 to 1903 in the Mediterranean Fleet, including such of His Majesty's ships as have called at Malta in passing through the Mediterranean Sea during that period. (Table II.)

Many of the cases occurred on board ships at considerable intervals of time from the vessel's last call at Malta, and it seemed useful to attempt some discrimination between cases that were possibly infected at Malta and those probably infected in some other port. I have accordingly separated the cases which occurred between 6 days and 20 days after a ship's last visit to Malta, and placed them in a separate column headed "Cases connected with Malta." This admits a certain amount of error, because a ship may have visited other ports and become infected at them during the interval of 20 days. I have no record of the ports visited other than Malta. In a few cases no date was assigned for the onset of the fever, and these I have put in the column referred to, in proportion to the number of days in the year spent at Malta by the ship on which they occurred.

For the three years set out in the table the ships, as a whole, show an incidence of 28·55 per 1000 of strength constantly in Malta, a rate corresponding closely with that of the garrison in Malta during the same three years (28·08 per 1000). The two rates, however, are not really comparable, that of the Navy being calculated on a population

Table

Name of Ship.	1901. Complement.	1901. No. of days in Malta.	1901. No. of cases of Mediterranean Fever.	1901. No. of cases of Mediterranean Fever connected with Malta.	1901. Men. Days in Malta.	1902. Complement.	1902. No. of days in Malta.	1902. No. of cases of Mediterranean Fever.
H.M.S.—								
Renown	758	255	16	14	193,290	758	166	17
Ramillies	746	158	34	30	117,868	746	123	7
Cæsar	759	211	13	11	160,149	759	190	19
Illustrious	759	262	16	15	198,858	759	161	12
Victorious	759	133	14	10	100,947	759	170	6
Royal Oak	714	204	4	2	147,696	714	60	4
Royal Sovereign	714	254	19	18	180,356	714	97	8
Empress of India	714	104	9	8	74,256	—	—	—
Canopus	753	219	16	12	164,907	753	209	21
Theseus	546	173	10	8	57,158	546	67	12
Andromeda	679	209	8	5	141,911	679	142	6
Vindictive	429	183	1	0	78,507	429	162	6
Tyne	101	266	1	1	26,866	101	231	3
Hibernia	676	365	14	14	246,740	729	365	20
Devastation	410	156	1	0	63,960	410	5	0
Rupert	294	19	13	4	5,586	294	10	0
Diana	450	116	7	5	52,200	450	193	16
Hood	694	174	7	7	119,756	694	174	21
Harrier	122	124	0	0	15,128	124	55	0
Vulcan	443	138	5	3	61,134	443	230	8
Pegasus	226	95	3	2	21,470	226	117	4
Implacable	780	31	3	0	24,180	780	213	25
Gladiator	429	138	4	2	59,202	429	216	6
Scout	147	72	1	1	10,584	—	—	—
Pioneer	224	172	1	0	38,528	224	209	9
Barham	175	187	2	1	32,725	175	194	1
Pyramus	224	194	9	8	43,456	224	178	12
Surprise	107	255	9	9	27,285	107	258	4
Halcyon	122	16	0	0	1,952	—	—	—
Dryad	121	212	6	5	16,552	121	226	7
Hussar	121	154	0	0	18,634	121	176	1
Salamander	91	134	0	0	12,194	—	—	—
Speedy	91	192	3	3	17,472	91	246	6
Ardent	53	217	0	0	11,501	53	169	0
Dragon	53	262	0	0	13,886	53	146	0
Kangaroo	63	61	0	0	3,843	63	237	0
Desperate	63	27	0	0	1,701	63	276	0
Myrmidon	63	27	0	0	1,701	63	242	0
Chamois	63	56	0	0	3,528	63	276	0
Bruizer	53	227	0	0	12,031	53	140	0
Banshee	53	227	0	0	12,031	53	290	0
Foam	63	260	0	0	16,380	63	233	0
Earnest	63	274	0	0	17,262	63	260	0
Griffon	63	274	0	0	17,262	63	278	0
Boxer	53	246	0	0	13,038	53	97	0
Hardy	53	167	0	0	8,851	—	—	—

II.

1902.		1903.					Cases per 1000 complement.		
No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	1901.	1902.	1903.
14	125,828	758	93	8	5	70,494	21·11	22·43	10·55
7	91,758	746	102	10	9	76,092	45·58	9·38	13·40
15	144,210	759	121	10	8	91,839	17·13	25·03	13·18
7	122,199	759	163	15	13	123,717	21·08	15·94	19·76
4	129,030	770	35	8	2	28,490	18·45	7·91	10·39
2	42,840	—	—	—	—	—	5·60	5·60	
5	69,258	—	—	—	—	—	26·61	11·20	
—	—	—	—	—	—	—	12·61		
16	157,377	753	8	5	2	6,024	21·25	27·90	6·64
12	36,682	—	—	—	—	—	18·32	23·96	23·96
4	96,418	—	—	—	—	—	11·78	8·83	
3	69,498	429	122	12	7	52,338	2·33	13·99	27·97
3	23,331	101	228	2	2	23,028	9·90	29·70	19·80
20	265,085	721	365	21	21	263,065	20·71	27·43	29·96
0	2,050	—	—	—	—	—	2·44	0·00	
0	2,940	—	—	—	—	—	44·22	0·00	
11	86,850	450	154	16	13	69,300	15·56	35·56	35·56
20	120,756	—	—	—	—	—	10·09	30·26	
0	6,820	124	86	0	0	10,664	0·00	0·00	0·00
8	101,890	443	96	4	2	41,528	11·29	18·04	9·03
2	26,442	226	196	3	3	44,296	13·28	17·70	13·28
22	166,140	780	199	23	12	155,220	3·85	32·05	29·49
5	92,664	429	160	5	2	68,640	9·32	13·99	11·66
—	—	149	5	0	0	745	6·80	—	0·00
6	46,816	224	99	3	2	22,176	4·46	40·18	13·39
1	33,950	—	—	—	—	—	11·42	5·71	
7	39,872	224	181	5	4	40,544	40·18	53·57	22·32
3	27,606	107	202	2	1	21,614	84·11	37·38	18·69
—	—	—	—	—	—	—	0·00		
6	27,346	121	171	16	13	20,691	49·59	57·85	132·23
1	21,296	123	139	0	0	17,097	0·00	8·26	0·00
—	—	—	—	—	—	—	0·00		
6	22,386	91	171	4	2	15,561	32·97	65·93	43·95
0	8,957	—	—	—	—	—	0·00	0·00	
0	7,738	—	—	—	—	—	0·00	0·00	
0	14,931	63	248	0	0	15,624	0·00	0·00	0·00
0	17,388	63	272	0	0	17,136	0·00	0·00	0·00
0	15,246	63	191	0	0	12,033	0·00	0·00	0·00
0	17,388	63	61	0	0	3,843	0·00	0·00	0·00
0	7,420	53	16	0	0	848	0·00	0·00	0·00
0	15,370	53	244	0	0	12,932	0·00	0·00	0·00
0	14,679	—	—	—	—	—	0·00	0·00	
0	16,380	63	164	0	0	10,332	0·00	0·00	0·00
0	17,514	63	208	0	0	13,104	0·00	0·00	0·00
0	5,141	53	80	0	0	4,240	0·00	0·00	0·00
—	—	—	—	—	—	—	0·00		

Table II

Name of Ship.	1901. Complement.	1901. No. of days in Malta.	1901. No. of cases of Mediterranean Fever.	1901. No. of cases of Mediterranean Fever connected with Malta.	1901. Men. Days in Malta.	1902. Complement.	1902. No. of days in Malta.	1902. No. of cases of Mediterranean Fever.
H.M.S.—								
Orwell	63	205	0	0	12,915	63	250	0
Coquette	63	253	0	0	15,939	63	242	0
Cygnet	63	186	0	0	11,718	63	242	0
Conflict	53	265	0	0	14,045	—	—	—
Cruiser	93	179	0	0	16,647	93	242	3
Imogene	42	75	0	0	3,150	53	91	0
Formidable	777	28	0	0	21,756	777	90	18
Pandora	226	10	0	0	2,260	226	174	0
Irresistible	—	—	—	—	—	780	145	5
Repulse	—	—	—	—	—	721	117	12
Flying Fish	—	—	—	—	—	63	175	0
Goldfinch	—	—	—	—	—	94	56	0
Bulwark	—	—	—	—	—	829	104	5
Vengeance	—	—	—	—	—	762	84	10
Aboukir	—	—	—	—	—	755	79	12
London	—	—	—	—	—	742	104	3
Hermione	318	12	0	0	3,816	324	141	11
Ariel	63	28	0	0	1,764	63	242	0
Naiad	—	—	—	—	—	276	76	3
*Orion	—	—	—	—	—	55	274	6
Panther	—	—	—	—	—	63	250	0
Locust	—	—	—	—	—	63	250	0
Thrasher	—	—	—	—	—	63	299	0
St. George	560	5	0	0	2,800	560	13	0
Juno	456	5	0	0	2,280	456	13	0
Rainbow	—	—	—	—	—	276	13	0
Brilliant	—	—	—	—	—	279	13	0
Albatross	—	—	—	—	—	69	137	0
Fawn	—	—	—	—	—	63	137	0
Mallard	—	—	—	—	—	63	123	0
Cynthia	—	—	—	—	—	63	126	0
Stag	—	—	—	—	—	63	14	0
Bat	—	—	—	—	—	63	14	0
Seal	—	—	—	—	—	63	14	0
Crane	—	—	—	—	—	63	14	0
Venerable	—	—	—	—	—	771	10	0
Bacchante	—	—	—	—	—	729	11	0
Intrepid	—	—	—	—	—	271	2	0
Mohawk	178	1	0	0	178	—	—	—
Russell	—	—	—	—	—	—	—	—
Montagu	—	—	—	—	—	—	—	—
Exmouth	—	—	—	—	—	—	—	—
Albemarle	—	—	—	—	—	—	—	—

* Since this table was made out, I have been informed that the cases returned as occurring on thus refer to a total complement of 1331 men. This accounts for the apparent absence of cases

—*continued.*

1902.		1903.					Cases per 1000 complement.		
No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	1901.	1902.	1903.
0	15,750	63	25	0	0	1,575	0 ·00	0 ·00	0 ·00
0	15,246	63	15	0	0	945	0 ·00	0 ·00	0 ·00
0	15,246	63	191	0	0	12,033	0 ·00	0 ·00	0 ·00
—	—	—	—	—	—	—	0 ·00		
3	22,506	93	89	1	1	8,277	0 ·00	32 ·28	10 ·75
0	4,823	41	59	0	0	2,419	0 ·00	0 ·00	0 ·00
10	69,930	777	183	18	12	142,191	0 ·00	23 ·17	23 ·17
0	39,224	226	115	1	1	25,990	0 ·00	0 ·00	4 ·45
3	113,100	780	125	14	8	97,500	—	6 ·41	17 ·95
6	84,357	721	74	4	1	53,354	—	16 ·64	5 ·55
0	11,025	63	263	0	0	16,569	—	0 ·00	0 ·00
0	5,264	—	—	—	—	—	—	0 ·00	
3	86,216	829	187	10	9	155,023	—	4 ·02	12 ·06
3	64,008	762	136	10	10	103,632	—	13 ·12	13 ·12
9	59,645	755	131	16	11	98,905	—	15 ·89	21 ·19
2	77,168	742	143	29	17	106,106	—	4 ·04	39 ·08
9	45,684	324	73	7	4	23,652	0 ·00	33 ·92	21 ·60
0	15,246	63	275	0	0	17,325	0 ·00	0 ·00	0 ·00
2	20,976	271	82	2	2	22,222	—	10 ·87	7 ·38
6	15,070	55	365	18	18	20,075	—	109 ·09	327 ·27
0	15,750	63	112	0	0	7,056	—	0 ·00	0 ·00
0	15,750	63	208	0	0	13,104	—	0 ·00	0 ·00
0	18,837	63	208	0	0	13,104	—	0 ·00	0 ·00
0	7,280	—	—	—	—	—	0 ·00	0 ·00	
0	5,828	—	—	—	—	—	0 ·00	0 ·00	
0	3,588	—	—	—	—	—	—	0 ·00	
0	3,627	—	—	—	—	—	—	0 ·00	
0	9,453	69	208	0	0	14,352	—	0 ·00	0 ·00
0	8,631	63	221	0	0	13,923	—	0 ·00	0 ·00
0	7,749	63	235	0	0	14,805	—	0 ·00	0 ·00
0	7,938	63	216	0	0	13,608	—	0 ·00	0 ·00
0	882	63	230	0	0	14,490	—	0 ·00	0 ·00
0	882	63	235	0	0	14,805	—	0 ·00	0 ·00
0	882	63	208	0	0	13,104	—	0 ·00	0 ·00
0	882	63	203	0	0	12,789	—	0 ·00	0 ·00
0	7,710	771	161	11	10	124,131	—	0 ·00	14 ·27
0	8,019	729	164	9	5	119,556	—	0 ·00	12 ·34
0	542	271	73	3	1	19,783	—	0 ·00	11 ·07
—	—	180	69	3	3	12,420	0 ·00	—	16 ·67
—	—	715	107	5	2	76,505	—	—	6 ·99
—	—	715	59	3	3	42,185	—	—	4 ·20
—	—	715	24	2	0	17,160	—	—	2 ·80
—	—	742	14	0	0	10,388	—	—	0 ·00

board H.M.S. "Orion" include cases which occurred on the torpedo-boat destroyer flotilla, and on board the torpedo-boat destroyer flotilla.

Table II

Name of Ship.	1901.					1902.		
	Complement.	No. of Days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.
H.M.S.—								
Arethusa	—	—	—	—	—	—	—	—
Thetis	—	—	—	—	—	—	—	—
Hawke	—	—	—	—	—	161	10	0
Spartiate	—	—	—	—	—	—	—	—
Europa	—	—	—	—	—	—	—	—
Sirius	—	—	—	—	—	—	—	—
Victoria and Albert	—	—	—	—	—	—	—	—
Minerva	—	—	—	—	—	456	6	0
Venus	452	17	0	0	7,684	—	—	—
Assaye	—	—	—	—	—	—	—	—
Porpoise	178	2	0	0	356	—	—	—
Merlin	—	—	—	—	—	—	—	—
Pique	—	—	—	—	—	—	—	—
Cossack	—	—	—	—	—	—	—	—
Leviathan	—	—	—	—	—	—	—	—
Goliath	—	—	—	—	—	—	—	—
Scylla	—	—	—	—	—	—	—	—
Diadem	—	—	—	—	—	—	—	—
Psyche	—	—	—	—	—	—	—	—
Duncan	—	—	—	—	—	—	—	—
Centurion	606	3	0	0	1,818	—	—	—
Argonaut	—	—	—	—	—	—	—	—
Arrogant	—	—	—	—	—	—	—	—
Furious	—	—	—	—	—	442	6	0
Undaunted	494	1	0	0	494	—	—	—
Ringdove	76	1	0	0	76	—	—	—
Peacock	76	2	0	0	152	—	—	—
Magicienne	224	1	0	0	224	—	—	—
Racoon	182	1	0	0	182	—	—	—
Linnet	92	4	0	0	368	—	—	—
Pigeon	76	1	0	0	76	—	—	—
Bonaventure	318	1	0	0	318	—	—	—
Marathon	224	1	0	0	224	—	—	—
Dido	450	2	0	0	900	—	—	—
Isis	450	2	0	0	900	—	—	—
Cockatrice	78	1	0	0	78	78	1	0
Melita	125	2	0	0	250	—	—	—
Ocean	751	2	0	0	1,502	—	—	—
Ophir	324	2	0	0	648	—	—	—
Rambler	113	87	0	0	9,831	—	—	—
Blake	128	2	0	0	256	—	—	—
Blenheim	592	2	0	0	1,184	—	—	—
Phœbe	217	2	0	0	434	—	—	—
Perseus	224	1	0	0	224	—	—	—
Talbot	442	1	0	0	442	—	—	—
Lapwing	78	1	0	0	78	—	—	—

—continued.

1902.		1903.					Cases per 1000 complement.		
No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	1901.	1902.	1903.
—	—	314	2	0	0	628	—	—	0 ·00
—	—	271	9	0	0	2,439	—	—	0 ·00
0	1,610	161	7	0	0	1,127	—	0 ·00	0 ·00
—	—	132	6	0	0	792	—	—	0 ·00
—	—	150	3	0	0	350	—	—	0 ·00
—	—	275	2	0	0	550	—	—	0 ·00
—	—	356	5	0	0	1,780	—	—	0 ·00
0	2,736	456	4	0	0	1,824	—	0 ·00	0 ·00
—	—	436	4	0	0	1,744	0 ·00	—	0 ·00
—	—	96	6	0	0	576	—	—	0 ·00
—	—	180	1	0	0	180	0 ·00	—	0 ·00
—	—	113	3	0	0	330	—	—	0 ·00
—	—	276	3	0	0	828	—	—	0 ·00
—	—	180	3	0	0	540	—	—	0 ·00
—	—	868	2	0	0	1,736	—	—	0 ·00
—	—	760	2	0	0	1,520	—	—	0 ·00
—	—	269	1	0	0	269	—	—	0 ·00
—	—	690	1	0	0	690	—	—	0 ·00
—	—	219	1	0	0	219	—	—	0 ·00
—	—	715	19	0	0	13,585	—	—	0 ·00
—	—	600	5	0	0	3,000	0 ·00	—	0 ·00
—	—	697	3	0	0	2,091	—	—	0 ·00
—	—	430	35	0	0	15,050	—	—	0 ·00
0	2,652	430	5	0	0	2,150	—	0 ·00	0 ·00
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
0	78	—	—	—	—	—	0 ·00	0 ·00	
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		
—	—	—	—	—	—	—	0 ·00		

Table II

Name of Ship.	1901.					1902.		
	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.
H.M.S.—								
Eclipse	455	3	0	0	1,365	—	—	—
Cressy	754	1	0	0	754	—	—	—
Albion	791	4	0	0	3,164	—	—	—
Fox	324	3	0	0	972	—	—	—
Iphigenia	105	6	0	0	630	105	1	0
Fearless	149	1	0	0	149	—	—	—
Mutine	105	2	0	0	210	—	—	—
Vestal	105	1	0	0	105	—	—	—
Amphitrite	327	3	0	0	981	327	4	0
Rinaldo	—	—	—	—	—	105	2	0
Espiègle	—	—	—	—	—	113	3	0
Daphne	—	—	—	—	—	138	2	0
Brisk	—	—	—	—	—	180	10	0
Aurora	—	—	—	—	—	503	1	0
Redpole	—	—	—	—	—	78	1	0
Plover	—	—	—	—	—	78	3	0
Pigmy	—	—	—	—	—	78	1	0
Astræa	—	—	—	—	—	321	1	0
Orlando	—	—	—	—	—	503	2	0
Endymion	—	—	—	—	—	553	1	0
Terrible	—	—	—	—	—	870	2	0
Majestic	—	—	—	—	—	806	6	0
Magnificent	—	—	—	—	—	799	6	0
Hannibal	—	—	—	—	—	769	6	0
Prince George	—	—	—	—	—	766	6	0
Jupiter	—	—	—	—	—	769	6	0
Mars	—	—	—	—	—	766	6	0
Niobe	—	—	—	—	—	689	6	0
Sutlej	—	—	—	—	—	755	6	0
Doris	—	—	—	—	—	426	6	0
Pactolus	—	—	—	—	—	229	6	0
Prometheus	—	—	—	—	—	229	6	0

Summary of Table II.

Totals.	1901.	1902.	1903.
Number of cases of Mediterranean Fever	249	349	338
Number of cases of Mediterranean Fever connected with Malta	198	266	241
Men—days in Malta	2,810,819	3,319,849	2,882,323
Average men constantly in Malta	7,700·87	9,095·48	7,896·77
Cases per 1000 complement	25·71	29·25	30·51
3 years' average	28·55		

—continued.

1902.		1903.					Cases per 1000 complement.		
No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	1901.	1902.	1903.
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
0	105	—	—	—	—	—	0·00	0·00	
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
0	1,308	—	—	—	—	—	0·00	0·00	
0	210	—	—	—	—	—	—	0·00	
0	339	—	—	—	—	—	—	0·00	
0	276	—	—	—	—	—	—	0·00	
0	1,800	—	—	—	—	—	—	0·00	
0	503	—	—	—	—	—	—	0·00	
0	78	—	—	—	—	—	—	0·00	
0	234	—	—	—	—	—	—	0·00	
0	78	—	—	—	—	—	—	0·00	
0	321	—	—	—	—	—	—	0·00	
0	1,006	—	—	—	—	—	—	0·00	
0	553	—	—	—	—	—	—	0·00	
0	1,740	—	—	—	—	—	—	0·00	
0	4,836	—	—	—	—	—	—	0·00	
0	4,794	—	—	—	—	—	—	0·00	
0	4,614	—	—	—	—	—	—	0·00	
0	4,596	—	—	—	—	—	—	0·00	
0	4,614	—	—	—	—	—	—	0·00	
0	4,596	—	—	—	—	—	—	0·00	
0	4,134	—	—	—	—	—	—	0·00	
0	4,530	—	—	—	—	—	—	0·00	
0	2,556	—	—	—	—	—	—	0·00	
0	1,374	—	—	—	—	—	—	0·00	
0	1,374	—	—	—	—	—	—	0·00	

often absent from Malta during the season when Mediterranean Fever is at its worst.

It appears that when Mediterranean Fever attacks the crew of a ship one year, it is very likely to attack the crew of the same ship in each of the following years that she remains on the station.* There is little relation between the number of days spent by a ship in Malta and the number of cases of Mediterranean Fever which occur on board her, but since no allowance is made in the table for the time of year at which the ship was in Malta, the relation may be closer or less close than is apparent here.

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* H.M.S. "Rupert" left the Mediterranean in February, 1902.

The facts seem to point to the ship herself becoming infected, and in some way assisting in the transmission of infection. Of course, the larger the crew the greater the chance of infection being introduced into the ship from outside. It must be remembered, however, that I am only dealing with a three-year period, which is altogether too short to base reliable conclusions upon.

The data from which the above table is compiled did not reach me until some time after I left Malta, so that I was unable to make investigation by its light on board ships which were at Malta during my visit. It may be said, however, that on larger ships the ventilation is better, and that on Destroyers, in particular, the closets are so constructed that they must be very difficult to cleanse.

The distribution of Mediterranean Fever amongst the garrison during the period 1897 to 1903 is shown in the following table, which

Table III.

	Number of cases of Mediterranean Fever admitted to hospital during the period 1897—1903.	Average number of men in occupation during each year of the period 1897—1903.	Average number of cases admitted per 1000 of strength per year during the period 1897—1903.
St. Francis, Floriana (R.E.) and Ravelin	20	194·86	14·7
Floriana (infantry)	249	572·14	62·2
Lower St. Elmo (infantry)	134	649·57	29·4
Upper ,, (R.G.A)	46	272·86	24·0
Tigne (R.G.A.)	54	412·57	18·7
Manoel (infantry), including huts	133	832·86	22·8
Notre Dame (infantry), including Ravelin and huts	49	217·14	32·2
Old laboratory (infantry and A.S.C.)	17	86·43	28·1
Marsamuscetto (infantry and A.O.C.)	18	74·43	34·5
St. James' Cavalier (R.G.A.)	12	129·86	13·2
Verdala (infantry)	104	534·14	27·8
Imtarfa (infantry and various)	224	989·29	13·7
Porte de Bombe tents	1	No record	available.
Castille (R.A. and R.E.)	1	17·86	8·0
Fort Madelina (R.G.A.)	1	25·71	5·6
Valetta Hospital (R.A.M.C.)	29	65·00	65·2
Mellieha Camp	33	273·40*	24·1*
Corradino Prison	6	16·00	53·6

* For period 1899—1903, not occupied before 1899.

Table III—*continued.*

	Number of cases of Mediterranean Fever admitted to hospital during the period 1897—1903.	Average number of men in occupation during each year of the period 1897—1903.	Average number of cases admitted per 1000 of strength per year during the period 1897—1903.
Camarata married quarters	15	82 ·86	25 ·9
Sliema married quarters	7	No record	available.
St. Clements (infantry)	5	50 ·00	14 ·3
Zabbar Gate ,,	10	93 ·86	15 ·2
Zeitun Gate ,,	4	55 ·43	10 ·3
Polverista ,,	35	156 ·86	31 ·9
St. Nicholas ,,	4	33 ·71	16 ·9
Vittoriosa ,,	3	47 ·43	9 ·0
Salvatore ,, (including C. Guard)	2	96 ·43	2 ·1
Fort St. Angelo (R.M.A. and infantry)	2	83 ·71	3 ·4
Couvre Porte (infantry and R.M.A.)	1	51 ·43	2 ·8
Inquisitor's Palace (infantry)	3	7 ·29	58 ·8
St. Paul's Bastion (infantry and A.S.C. stables)	4	26 ·29	21 ·7
St. John's Bastion (infantry)	1	22 ·43	6 ·4
Fort Ricasoli (R.G.A.)	40	495 ·14	11 ·5
,, Rinella ,,	1	15 ·86	9 ·0
,, Delimara ,,	6	23 ·43	36 ·6
,, San Leonardo (R.A. and R.E.)	3	25 ·14	17 ·0
,, della Grazia (R.G.A.)	2	13 ·00	22 ·0
,, San Francesco (infantry)	2	23 ·71	12 ·0
,, Isola Gate (infantry)	8	39 ·14	29 ·2
Cottonera Hospital (R.A.M.C.)	25	44 ·14	80 ·9
Pembroke (R.G.A. and infantry)	49	187 ·14	37 ·4
Duerra Lines (R.G.A.)	1	4 ·57	31 ·9
Ghain Tuffieha	99	370 ·67*	89 ·0*
St. George's Barracks (R.G.A. and infantry)	108	1024 ·71	15 ·1
Forrest Hospital (R.A.M.C.)	1	9 ·43	15 ·1
Gozo	24	199 ·86	17 ·2
Fort Lascaris (R.M.A.)	29	253 ·86	16 ·3
Living in places not mentioned above	0	443 ·29	00 ·0
Whole garrison	1625	9037 ·43	25 ·6

is compiled from information furnished me by the Director of Transport and Supplies, and by the Principal Medical Officer in Malta. The cases are only those admitted to hospital, and would include all cases occurring amongst the garrison except a few officers who were nursed at their own homes. Of these I could not obtain a record.

The average annual attack rate for the whole garrison, as far as

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* For years 1901, 1902, and 1903, not occupied before 1901.

TABLE IV.

Age	1902.					1903.					1902 and 1903.
	Average strength.	Admissions to hospital on account of Mediterranean Fever.	Deaths from Mediterranean Fever.	Ratio per 1000 of strength per year.		Average strength.	Admissions to hospital on account of Mediterranean Fever.	Deaths from Mediterranean Fever.	Ratio per 1000 of strength per year.		Ratio per 1000 of strength per year.
				Admissions.	Deaths.				Admissions.	Deaths.	Admissions.
Under 20 years	1032	14	0	13 ·6	0 ·00	1041	67	3	64 ·4	2 ·88	39 ·8
From 20 to 25 years ..	2939	45	1	15 ·3	0 ·34	3460	196	1	56 ·6	0 ·29	37 ·7
,, 25 30 ,, ..	1926	18	1	9 ·3	0 ·52	1495	53	1	35 ·4	0 ·67	20 ·8
,, 30 35 ,, ..	1498	24	3	16 ·0	2 ·00	1117	34	2	30 ·4	1 ·79	22 ·2
,, 35 40 ,, ..	1593	39	0	24 ·5	0 ·00	1294	37	1	28 ·5	0 ·77	26 ·3
40 years and upwards .	230	15	1	65 ·2	4 ·35	386	17	1	44 ·0	2 ·59	57 ·9
Totals	9218	155	6	16 ·8	0 ·65	8793	404	9	45 ·9	1 ·02	31 ·0

this record goes, was 25·6 per 1000 during the seven-year period 1897 to 1903. The heaviest incidence was upon Floriana Infantry Barracks, Valetta Station Hospital, Cottonera Hospital, and Ghain Tuffieha Camp. The two* first places are specially dealt with subsequently; the heavy incidence upon Ghain Tuffieha Camp was occasioned by an outbreak in 1903. A large number of men annually occupy the camp for a few months during the summer only, so that an outbreak occurring amongst them raises the figure representing the annual case incidence out of proportion to the importance of the outbreak itself, because the representative figure is calculated on the average occupation during the whole year.

Age and Sex Incidence could not be ascertained from the civil official returns, but next autumn figures which are now being collected for the year ending July 31, 1905, will be available.

The age incidence for the garrison during 1902 and 1903 is shown as far as possible in Table IV (see page 32).

The two years tabulated show considerable disparity in the number of admissions and in the resulting ratios per 1000 of strength. From the figures of the two years together, it would appear that men under 25 years of age suffer more than the average number of attacks per 1000. From 25 to 40 there is a degree of immunity becoming less with advancing years. Over age 40 the incidence again becomes severe. The deaths are too few to permit of any useful deductions being made from them.

Length of Service in Malta is, as might be expected, closely connected with age in its influence upon the incidence of Mediterranean Fever, as the following table shows (see page 34).

The heaviest incidence of Mediterranean Fever is upon men with less than one year's service; in fact, they are the only class shown with an incidence greater than the average incidence of the disease upon all classes taken together. The incidence upon men with over two years' service is less than half that upon men with under two years' service, and the severity of incidence continues to decrease with length of service up to five years, after which it again rises. In the last three classes shown in the table, however, the numbers dealt with are too small to carry much weight.

The decrease of incidence with length of service in Malta is, no doubt, influenced to a large extent by the elimination of the more susceptible subjects. Further figures will be available next autumn.

The Case Mortality amongst the civil population differs enormously in different localities, as is to be expected when dealing with small numbers and unreliable notification returns. Amongst the civil population of Malta, 8·9 cases per 100 attacked died during the period

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* There was an outbreak of Mediterranean Fever in Floriana infantry barracks during 1903. The details were not obtained in time for inclusion in this report.

TABLE V.

Length of service in Malta.	1902.					1903.					1902 and 1903.
	Average strength.	Admissions to hospital on account of Mediterranean Fever.	Deaths from Mediterranean Fever.	Ratio per 1000 of strength per year.		Average strength.	Admissions to hospital on account of Mediterranean Fever.	Deaths from Mediterranean Fever.	Ratio per 1000 of strength per year.		Ratio per 1000 of strength per year.
				Admissions.	Deaths.				Admissions.	Deaths.	Admissions.
Under 1 year........	4878	103	3	21 ·1	0 ·62	4543	261	2	57 ·5	0 ·44	38 ·6
From 1 to 2 years....	1913	30	1	15 ·7	0 ·52	3142	117	5	37 ·2	1 ·59	29 ·1
,, 2 3 ,, ...	1190	10	0	8 ·4	0 ·00	550	16	2	29 ·1	3 ·64	14 ·9
,, 3 4 ,, ...	550	6	1	10 ·9	1 ·82	259	6	0	23 ·2	0 ·00	14 ·8
,, 4 5 ,, ...	309	3	0	9 ·7	0 ·00	173	0	0	00 ·0	0 ·00	6 ·2
,, 5 10 ,, ...	292	2	1	6 ·8	3 ·42	106	4	0	37 ·7	0 ·00	15 ·1
10 years and upwards.	86	1	0	11 ·6	0 ·00	20	0	0	00 ·0	0 ·00	9 ·4
Totals	9218	155	6	16 ·8	0 ·65	8793	404	9	45 ·9	1 ·02	31 ·0

1894 to 1903, and amongst the civil population in Gozo, 8·4 per 100 attacked died during the same period. These figures form a striking contrast to the case mortality of the Army and of the Navy. In the Army, during the period 1897 to 1903, the case mortality was 3·2 per cent., and in the Navy it was only 1·4 per cent. during the period 1897 to 1901. It is probable that the case mortality is higher amongst the civil population than in the Army and Navy, owing to the superior nursing and attention enjoyed by the services, but I do not think it likely that the difference noted above represents the true state of affairs. Probably the high case mortality among the civilians is largely due to the fact that mild cases of Mediterranean Fever more often escape notification than severe ones.

Temperature and Rainfall in Connection with Mediterranean Fever.—No official data were available with regard to temperature and rainfall for the whole of the period 1894 to 1903. The curves in the accompanying chart are constructed from figures kindly supplied me by the Rev. Father J. F. Dobson, S.J., the result of observations made at St. Julian's, near Valetta. I have inserted also a curve representing the case incidence of Mediterranean Fever, for comparison. The last-named curve is based on figures taken from the civil official notification records (see next page).

It will be at once seen that there is a very close correspondence between the curve representing the temperature and that representing the number of cases. The rise of the latter curve follows that of the former at an interval of about one month, which would be approximately sufficient to allow for incubation and notification if the incidence of fever were directly dependent upon the temperature of the air. The temperature curve attains its maximum in July and continues high during August, after which it begins to drop. The case curve attains its maximum a month later, but, unlike the temperature curve, it at once commences to drop, so that it would appear that whatever connection the air temperature may have with case incidence, does not remain so obvious after the former has attained its maximum.

The curve representing rainfall is in general the inverse of that representing temperature. It attains its minimum in July, but it is almost as low in June and August. The "case" curve commences to drop at the same time that the rainfall curve commences to rise, allowing no interval for incubation and notification, so that the connection is not clear; nor does the steep rise of the rainfall curve, at the end of September, produce a correspondingly steep decline in the case curve as might have been expected were the connection between the two intimate.

Seasonal Prevalence of Mediterranean Fever.—On p. 37 will be found a table giving the number of cases that were notified each month of

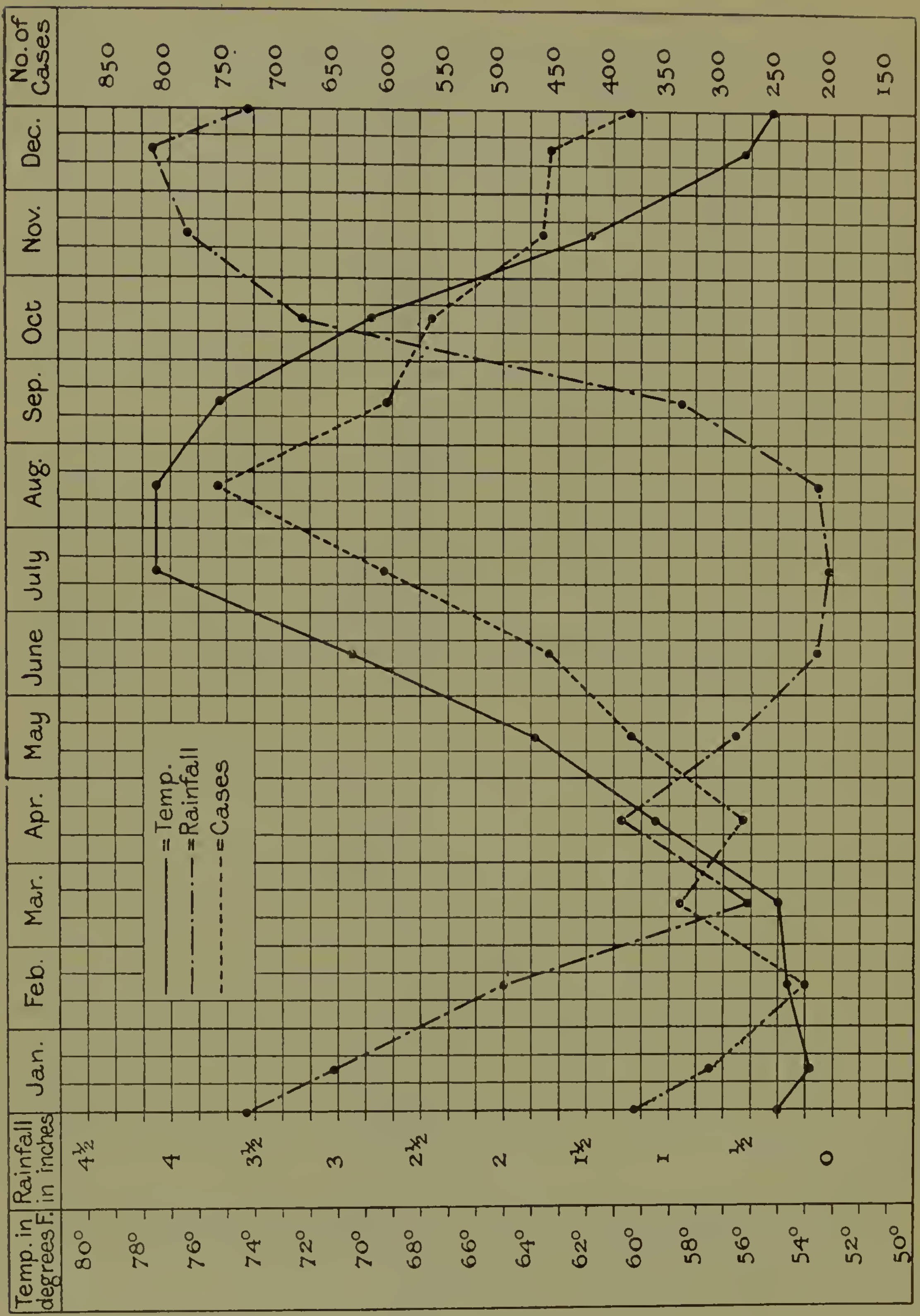

Chart showing temperature, rainfall, and number of cases amongst the civil population during period 1894—1903.

each year of the period 1894 to 1903, together with the total number of cases which were notified during the period in each month.

The figures in Table VI probably represent with some accuracy the seasonal prevalence of Mediterranean Fever, because though they are founded upon the civil official notification returns, there does not appear to be any particular reason why these returns should be more inaccurate at one time of the year than at another.

Table VI.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1894	22	6	35	28	24	18	44	22	53	30	16	21
1895	10	9	21	23	11	26	16	47	42	18	27	12
1896	18	11	16	27	70	69	126	145	71	33	31	30
1897	28	25	22	30	52	50	92	89	49	47	41	38
1898	41	16	17	20	36	32	49	40	50	64	54	88
1899	61	33	49	39	47	63	105	77	58	103	91	71
1900	38	30	37	33	37	42	65	83	79	78	82	44
1901	46	32	25	24	41	67	74	89	78	64	43	42
1902	17	34	37	34	33	37	66	84	71	61	49	65
1903	32	26	31	23	35	54	68	82	54	71	33	44
Total	313	222	290	281	386	458	605	758	605	569	467	455

The maximum prevalence would appear to be in the month of August and the minimum in February. It is to be noted that the number of cases notified during February does not approach zero, being roughly 30 per cent. of the number notified in August.

From February to August there is each month a steady increase in the number of cases, except for a slight drop-back in April, and from August to February a steady decrease.

Consideration of Ways in which the Infection of Mediterranean Fever may be Transmitted.

(1) *Direct Personal Infection* (that is, by contact, or by the breath, or by the saliva).—No reliable data as to the number of dwellings in which more than one case of Mediterranean Fever occurred, could be obtained from the official notification records. The name of the patient was seldom given, and on visiting an address which had appeared more than once in the records, it was generally found to be a tenement house occupied by 15 or 20 families. Often there was no record of the number of the house, the street only being indicated.

Amongst 100 houses which I personally visited, in all of which Mediterranean Fever had been notified during 1904, I only found six houses in which there had been more than one case notified. There was often strong probability that other cases of a lighter nature than that notified had occurred, but the information elicited was never conclusive.

In Malta, outside Valetta, Cospicua, Vittoriosa, and Senglea, as noted above, both density of population upon area, and aggregation of a large number of persons in one locality appear to favour the spread of Mediterranean Fever. This may be because such conditions give greater opportunity for close personal contact, and so for direct personal infection. In making any inference it must not be forgotten that Valetta and the three cities are exceptions, although both conditions are present in an eminent degree. It would appear, therefore, that whatever may be the conditions which favourably differentiate Valetta and the three cities from the rest of Malta, they must have an enhanced importance in their bearing upon the spread of Mediterranean Fever, inasmuch as they seem to more than counterbalance two conditions which appear to favour the spread of the disease in other parts of Malta.

Thirty-five women, wives of non-commissioned officers in the garrison, were attacked by Mediterranean Fever during 1904. Only two of them were removed to hospital. If direct personal infection were always an important factor in the spread of Mediterranean Fever, it would be expected that a large proportion of the husbands of these women would have been attacked, yet only five fell ill. Moreover, in two cases out of the five the husband and wife appear to have fallen ill on the same day, which would point rather to infection from a common source, than to infection from husband to wife, or *vice versâ.*

Set out in the following table is a comparison between the three principal hospitals of Malta, showing separately the incidence of Mediterranean Fever upon the nursing staffs, and upon the patients undergoing treatment in hospital for other diseases, during the five years 1899 to 1903 respectively. I have added to the table, for comparison, the incidence of Mediterranean Fever upon the troops quartered in Valetta during the same period.

The number of patients per 1000 constantly ill, in other words, per mean yearly number of patients in hospital, is not strictly comparable with that of the staff per 1000 of strength, because in the former we are dealing with a shifting population in which fresh patients would constantly become exposed to infection, if the hospital were a centre of infection, whereas the staff would not vary in the same degree. In addition, the patients in hospital would be more numerous in summer, owing to "simple continued fever," than in winter.

It will be seen that during the period the average incidence of Mediterranean Fever upon patients treated in the Station Hospital, Valetta, was less than that upon the troops quartered in Valetta, while in the other two hospitals it was much greater. In all three hospitals very severe incidence occurred on the nursing staffs.

For the better consideration of the difference of incidence upon the respective staffs of the three hospitals I add here a short note upon each.

The Station Hospital, Valetta, has only attempted to isolate Mediterranean Fever since 1903. The isolation is incomplete; the Mediterranean Fever wards are separated from other wards only by a wall reaching about half-way to the ceiling. Enteric cases are frequently put in the Mediterranean Fever wards, and I have seen at least one case of Mediterranean Fever in a general ward.

Table VII.

	Valetta Station Hospital.			Central Civil Hospital.			R.N. Hospital, Bighi.			Valetta troops.
	No. of cases of Mediterranean Fever admitted.	No. of cases of Mediterranean Fever which occurred amongst hospital patients per 1000 constantly ill.*	No. of cases of Mediterranean Fever which occurred amongst hospital orderlies per 1000 of strength.	No. of cases of Mediterranean Fever admitted.	No. of cases of Mediterranean Fever which occurred amongst hospital patients per 1000 constantly ill.*	No. of cases of Mediterranean Fever which occurred amongst hospital nursing staff per 1000 of strength.	No. of cases of Mediterranean Fever admitted.	No. of cases of Mediterranean Fever which occurred amongst hospital patients per 1000 constantly ill.*	No. of cases of Mediterranean Fever which occurred amongst sick bay staff per 1000 of strength.	No. of cases of Mediterranean Fever per 1000 of strength.
1899..	84	32 ·00	34 ·48	129	58 ·44	171 ·4	111	66 ·67	83 ·3	22 ·54
1900..	85	6 ·44	54 ·03	147	100 ·63	171 ·4	261	89 ·55	459 ·5	26 ·18
1901..	127	45 ·75	121 ·21	127	96 ·15	138 ·9	175	78 ·43	122 ·0	43 ·11
1902..	60	34 ·18	48 ·78	127	47 ·62	111 ·1	272	175 ·50	476 ·2	16 ·90
1903..	222	12 ·26	50 ·00	154	83 ·80	83 ·2	279	102 ·74	150 ·3	17 ·31
		25 ·9	56 ·5	—	77 ·2	134 ·8	—	105 ·18	289 ·34	34 ·31

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* The number of cases which occurred amongst hospital patients was calculated for each hospital by reckoning all cases of Mediterranean Fever which occurred in patients more than 14 days after their admission, and less than 14 days after their discharge. Patients who were admitted suffering from a disease that might have been Mediterranean Fever are excluded.

The means provided for the disposal of bed-pan contents and slops are wholly inadequate. A separate slop sink is used for enteric and Mediterranean Fever cases only. It is, however, on a different landing to the wards, and at a considerable distance. It is not supplied with a proper flush for cleansing purposes, and it is in a small dark room with faulty pavement. Some bed-pans examined by me were found to be very foul, though supposed to be cleansed. Izal is used for disinfecting the bed-pans, and carbolic solution for the orderlies' hands. The patients are cleansed with carbolic solution after the bed-pan has been used, and izal is put in the bed-pan before use.

Water-closets are used by enteric and Mediterranean Fever convalescents in common with other convalescents. The urinal provided is of the perpendicular slab type with an insufficient flush. It smelt offensively and the floor was soiled with urine.

The hospital orderlies spend about 50 hours per week in the wards.

The Royal Naval Hospital, Bighi, has isolated Mediterranean Fever for the past three years in special wards. These wards are amply provided with modern hospital sinks containing powerful flushes. Three of the sinks in the hospital were not ready for immediate use at the time of my visit. Izal is placed in the bed-pan before use, and an india-rubber sheet is put under the patient. The sheet shown me was perished and soiled. The patient is cleaned with soap and water, but the attendant does not disinfect his hands as a routine matter.

The sick-bay staff spend between 66 and 71 hours in the wards per week. Soiled linen is conveyed to the laundry by the sick-bay staff and washed with the other linen.

The Central Civil Hospital.—No attempt is made here to isolate patients suffering from Mediterranean Fever. They are distributed at haphazard throughout the medical wards.

Bed-pans are emptied into a gully in an open space between the wards. The edges of the gully are protected by a metal funnel, but the bed-pans are carried carelessly across the open space, dripping portions of their contents on the pavement, and are roughly washed out at a hot-water tap over an ordinary grating.

The attendant does not cleanse his hands after the operation, and the bed-pan is not usually disinfected, though occasionally a small portion of "carbolic" powder is dusted into it. No attempt was made to cleanse the patient at the time of my visit, and his person and bed proved upon inspection to be in a filthy condition.

Infected clothing is said to be steeped in tubs containing a 1 in 1000 solution of corrosive sublimate before removal to the laundry at the poor-house. At the time of my visit there was no infected clothing in the two small tubs shown me, and I was informed that the liquid they contained was not corrosive sublimate solution.

The nurses spend practically all their time in the wards, eating and sleeping there; but they have a holiday every third day from midday until 6 the next morning, or if it happen to be a visiting day (Wednesday or Sunday), they leave at 4 P.M. instead of midday. In addition, they have a holiday every three weeks from 9 A.M. to 6 A.M. the following day.

Male ward cleaners have the same hours except that they leave hospital on alternate days at 5 P.M., returning at 6 A.M., and on alternate Sundays from 8 A.M. to 6 A.M. on Monday.

Briefly, the Military Station Hospital has practised partial isolation during 1903.

The Royal Naval Hospital has practised complete isolation during the past three years.

The Central Civil Hospital has made no attempt at isolation.

The Military Hospital and the Naval Hospital take precautions against the spread of infection by excreta; while in the Civil Hospital such precautions are almost altogether neglected.

The incidence upon the staffs of the three hospitals is not in proportion to the precautions taken against infection, nor to the number of hours spent in the wards.

The patients and attendants in the civil hospital are entirely Maltese, and if the incidence upon either the one or the other be compared with the incidence upon the civil population of Malta as a whole, the result is remarkable. The attendants show an incidence of 134·8 per 1000, the patients 77·2 per 1000 constantly ill, while the civil population of Malta shows only 3·2 per 1000 during the 10 years, 1894 to 1903. These results are no doubt due largely to faulty notification.

It is possible that so-called endemic acquired immunity may play a part in reducing the incidence on the patients and attendants in the civil hospital, and that such immunity may invalidate comparisons with hospitals occupied altogether by Englishmen.

If the Valetta Station Hospital be compared with the Naval Hospital it will be found that the incidence of Mediterranean Fever upon the respective staffs and patients is not in proportion to the amount of isolation attempted, but is more or less in proportion to the amount of care exercised in disposing of the excreta of patients, and the number of hours spent in the wards by the attendants.

The cause of special incidence of Mediterranean Fever in the hospitals does not, on the evidence obtained, appear to be direct personal infection, since that would probably be more evident in the hospital where least isolation is attempted. The incidence, mentioned above, on non-commissioned officers whose wives suffered from Mediterranean Fever points in the same direction. Neither is the evidence in favour of a place infection, to which the patients would probably be more exposed than the staff, and would, in addition, constantly present fresh material.

It is possible that an aggregation of cases of Mediterranean Fever in one place may be more infective than the same number spread over a large area, but we have no evidence to point to this. In the Naval Hospital during 1904—a very short period, no doubt—only one case of Mediterranean Fever arose amongst the patients occupying the adjoining wards to the Mediterranean Fever wards. A table showing the cases of Mediterranean Fever which occurred amongst patients in the Naval Hospital during 1904 will be found on p. 49.

(2) *Excretal infection* may occur by means of infected dust inhaled or swallowed, by contamination of the hands, and thence the mouth, or by contamination of food or drink.

Dust is very prevalent out of doors in Malta, because of the friable nature of the rock and the hot sun, and owing to the high winds prevalent, opportunity of inhaling or swallowing it is present during the greater part of the year. There is, without doubt, possibility of frequent pollution of the dust by the excreta of mild or unrecognised cases, more especially in the suburban area, where conveniences are few and scavenging desultory. Horrocks has shown that the *Micrococcus melitensis* is found in the urine of Mediterranean Fever patients, and that it can live for long periods in a desiccated condition.

The seasonal curves of temperature and rainfall are such that the degree of dust prevalence corresponds closely with the degree of Mediterranean Fever prevalence. It is true that the Mediterranean Fever curve begins to fall immediately after attaining its maximum, while the curve of temperature remains high and the curve of rainfall low; but that may be accounted for by the fact that the "Sciroc" wind begins to blow in August. I am informed that this wind is so laden with moisture that it renders the roads damp during its prevalence in August and September. I cannot say I observed this phenomenon during my stay in Malta, but during the summer of 1904 there was very little " Sciroc," although the temperature was unusually high.

The rainfall curve is on the whole consistent with the theory of dust infection, being in general the inverse of the Mediterranean Fever curve; but I understand that during long periods in the rainy season there is little or no dust. If this be so, and dust be largely concerned in the spread of infection, it would be expected that there would be corresponding periods almost free from Mediterranean Fever notifications, which is not the case.

I have made out the following table with a view to comparing the incidence during the most dusty months of the period 1894 to 1903 with that during the least dusty months, for the three areas, urban, suburban, and rural.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Urban area—												
Valetta	19	14	30	12	20	23	63	40	37	20	33	29
Floriana	15	5	16	16	14	36	33	40	29	26	23	17
Cospicua	8	8	4	7	8	45	38	28	16	21	10	8
Vittoriosa	8	7	6	3	7	20	15	23	28	21	12	14
Senglea	5	1	3	3	7	9	8	11	17	7	5	8
	55	35	59	41	56	133	157	142	127	95	83	76
Suburban area—												
Misida and Pietá	14	10	6	6	7	16	35	41	24	20	15	14
Sliema and St. Julian's	25	15	22	26	28	36	75	58	63	53	21	48
Hamrun	30	26	35	38	43	46	63	117	63	69	44	33
Birchirchara	37	29	26	27	25	34	66	45	48	45	32	27
Curmi	1	4	3	2	2	3	6	12	3	5	6	1
Tarxien and Paola	5	6	5	7	11	10	9	10	6	10	13	9
Zabbar	19	10	23	7	18	14	22	25	19	22	18	17
	131	100	120	113	134	159	276	308	226	224	149	149
Rural area—												
Notabile and Rabato	15	10	7	18	14	18	40	24	21	33	13	30
Dingli	1	2	—	2	1	2	2	6	8	5	—	1
Zebbug	16	12	15	16	25	12	28	46	37	31	30	22
Siggeui	3	3	6	3	5	5	14	12	11	8	5	11
Lia, Attard, and Balzan	10	3	12	28	37	19	49	50	37	42	24	19
Naxaro	6	6	4	1	7	8	9	13	17	14	15	9
Musta	20	4	5	9	4	11	11	18	19	34	44	12
Gargur	—	—	1	—	—	2	2	5	6	5	8	2
Mellieha	1	1	—	1	1	2	—	4	2	6	6	2
Luca	—	—	1	4	1	2	2	2	3	2	4	5
Zurrico	10	4	2	1	3	5	12	6	14	12	5	13
Krendi	—	—	1	2	4	1	4	6	3	2	2	6
Safi	1	3	—	—	1	1	1	2	—	1	1	—
Micabiba	1	1	—	—	1	—	2	5	3	3	2	5
Chircop	—	1	—	—	1	1	2	3	2	2	—	2
Zeitun	13	10	13	13	24	10	32	31	26	9	25	16
Axiak	4	1	1	1	1	4	3	3	8	1	3	3
Gudia	3	—	2	1	1	4	8	4	2	2	1	2
	104	61	70	100	131	107	221	240	219	212	188	160

I take March to September inclusive as being the driest and consequently the most dusty months; and January, February, October, November, and December as the wettest and least dusty months. Allowing a month for incubation and notification, we have April to October representing the dry part of the year and the remaining months the wet.

In the urban area the average number of cases in the dry season was 10·73 per month, and in the wet season 6·16; that is in the proportion of 100 to 56.

In like manner in the suburban area the average number of cases per month in the dry season bears to the average number of cases per month in the wet season the proportion of 100 to 63, while a similar comparison in the rural area gives a proportion of 100 to 66.

	Proportion of cases per month in the wet season to the cases per month in the dry season.
Urban area	100 to 56
Suburban area	100 ,, 63
Rural area	100 ,, 66

This is not the result to be expected had contaminated dust contributed largely to the spread of Mediterranean Fever. There is less dust in the urban area, and less opportunity for dust contamination, on account of superior paving, draining, and scavenging, and also because all the urban area abuts upon the sea, much of it being built on tongues of land almost surrounded by water. It would be expected that the difference between the prevalence of Mediterranean Fever in the dusty season and in the wet season would prove least marked in the urban area, but, on the contrary, the difference is most marked in this area. These figures, taken for what they are worth, do not indicate that contaminated dust in the open air has a marked influence upon the incidence of Mediterranean Fever.

In the consideration of excretal infection by way of the hands or by way of food, special incidence upon certain hospital nurses and orderlies who have the handling and cleansing of Mediterranean Fever patients has already been noticed under the heading "Direct Personal Infection."

Abundant opportunity for soiling the hands and for pollution of the food is afforded by the methods of excreta disposal in use in the islands, which have already been referred to in Part I of this report. Amongst 100 houses examined in which Mediterranean Fever had occurred during 1904, I found that 75 had faults of one kind or another which rendered pollution of the hands, or of food, with excretal matter, probable. Amongst 40 other houses not infected with

Mediterranean Fever during 1904, but examined by way of control, I found 55 per cent. suffering from faults of a like kind. The control houses were selected by reason of their similarity to the infected houses; they were very often next door, and they were always of the same class and in the same neighbourhood as the infected houses. Large figures, however, extending over several years, would be required to give value to such data as these. Such as it is, however, the evidence is in favour of the probability of excretal pollution of the hands or food, or of dust inside houses having played a part in the spread of infection. As against this probability there is the fact that amongst the civil population, where opportunity for this kind of infection is far greater than amongst the garrison or Navy, the case incidence of Mediterranean Fever is in general about one-eighth as severe. Here, however, the notification returns are probably at fault.

(3) *Newly-turned earth* has been suspected by more than one observer to be a cause of outbreaks of Mediterranean Fever. When the porous nature of the rock in Malta is considered together with the fact that sewage has been allowed to percolate into it, and into the soil above it, for centuries, it does not seem remarkable that digging operations should have been suspected.

Mr. Cartwright-Read, the Admiralty Superintendent of Works, kindly undertook to furnish me with immediate notice of cases of sickness arising amongst the men employed by him on digging operations in Fort St. Angelo during my stay in Malta. In July 255 men were employed, in August 327, and in September 337. All men absent from work on account of illness during these three months were visited and reported upon, and no case of Mediterranean Fever was discovered. The ground opened up was probably at one time very much fouled, part of it having been the ancient prison of the galley slaves employed by the Knights of St. John.

The Honourable Mr. Gatt, Superintentent of Public Works to the Maltese Government, kindly placed similar facilities at my disposal with regard to gangs of men at work laying sewers during July, August, and September of 1904. The numbers of men employed were 200, 230, and 310, in each month respectively. No case of Mediterranean Fever was detected amongst them.

It appeared to me possible that the men at work in sewer laying had attained a certain immunity from infection, such as is said to be acquired by sewer men at home, and that the opening of the earth might have had a deleterious effect upon the health of the occupants of the houses in the localities where the sewers were being laid.

Curmi, Misida, and Sliema have been sewered during the last few years, the actual period occupied in laying sewers being for Curmi, March, 1901, to October, 1901; for Misida, the whole of 1903; and for Sliema, November, 1901, to October, 1902. Contrasted with the five-year period 1899 to 1903 there was, as shown below, a slightly greater incidence of Mediterranean Fever in Sliema, and a considerably smaller incidence in Misida during the period that sewers were being laid. In Curmi the incidence was about three times as severe during the laying of the sewers as it was during the five-year period, but here we are dealing with only a very small number of cases. On the whole, the figures below do not indicate that opening streets to lay sewers has any marked effect in increasing the prevalence of Mediterranean Fever.

Table IX.

	I. Period during which work was in progress.	II. Average number of cases of Mediterranean Fever per year per 10,000 inhabitants.	
		During the period set out in Column I.	During the period 1899—1903.
Sliema	Nov., 1901—Oct., 1902	46·9	43·3
Misida	1903	74·4	83·6
Curmi	Mar.—Oct., 1901......	27·6	9·5

(4) *Biting Insects.*—Further investigation is necessary before any definite pronouncement can be made as to the part, if any, taken by biting insects in the spread of Mediterranean Fever. Up to the present little is known as to the life history, distribution, and seasonal habits of even the commoner biting insects found in the Maltese Islands. I have, for instance, evidence that mosquitoes bite in the winter in Malta, but I do not know what kind of mosquitoes do so. The sand fly is very prevalent in parts of Malta during the summer, but there is little information as to his breeding places or his time of flight, or his winter habits.

The researches of Shaw and Gilmour would show that it must be a matter of some difficulty for a biting insect to infect himself from the human subject, seeing the sparse numbers in which the Micrococcus has been found in the peripheral circulation, and the small amount of blood the insect is capable of taking. Similarly, the chances would be infinitesimal of an insect carrying even a single *Micrococcus melitensis* mechanically upon his proboscis. On the other hand, it may be said that if certain biting insects, like mosquitoes, were capable of infecting themselves with Mediterranean Fever and of transferring the infection, the disease would be much more prevalent than it is.

The special incidence upon hospital orderlies, in comparison with hospital patients, is against the biting insect theory. The patients would be more likely to get bitten by infected insects than would hospital orderlies, both on account of being constantly in the wards and because they are less able to defend themselves.

(5) *Water* does not appear to have played any considerable part as a carrier of Mediterranean Fever infection in Malta. The public water supply, which is reasonably free from suspicion of contamination, is laid on to every village in Malta except Mellieha, but most householders have an alternative supply in the shape of a rain-water tank, usually open to contamination. Generally speaking, the public water supply is not laid on to the houses, but is fetched from a stand-pipe, and it is apparent that there is often opportunity for contamination in process of transit, or on account of the place where the water is kept. I personally inspected 100 houses in which Mediterranean Fever had occurred during 1904, and as far as I could judge, 35 of them had a water supply that was not reasonably liable to contamination. Out of 40 houses inspected by way of control, 27 per cent. had a water supply which was not reasonably liable to contamination. In the same two groups of houses, 85 of the infected class used the public water service, while only 65 per cent. of the control class used it.

A comparison between the figures relating to enteric fever, often a water borne disease, and the figures relating to Mediterranean Fever, shows little correspondence in the distribution of the two diseases. For example, the average number of cases of enteric fever per 10,000 inhabitants in Malta per year of the period 1894 to 1903 was 7·2, and the incidence on the three areas referred to previously was as follows:—

Urban area............	7·5	per 10,000 inhabitants	per annum
Suburban area	6·6	,,	,,
Rural area	6·9	,,	,,

I do not profess to account for this distribution of enteric fever, but it is obviously entirely different from that of Mediterranean Fever.

No connection has ever been demonstrated between any particular branch of the public water supply, nor between any particular well or tank, and an outbreak of Mediterranean Fever, though such connection has frequently been shown with outbreaks of enteric fever in Malta.

Aërated waters are much drunk in the summer time in Malta, but here the question is still one of water. The manufacture is carried on under Government inspection; the water used is generally the public water supply, and in some cases distilled water. No connection has ever been traced between aërated waters and Mediterranean

Fever; indeed, the majority of rural dwellers who are attacked by Mediterranean Fever seldom take aërated waters. The urban and suburban areas, where aërated waters are most taken, do not show a higher incidence of the disease than the rural area.

(6) *Milk* is not so closely connected with water in Malta as it is in most other countries, because the great majority of people get their milk supply in their own vessels direct from the goat.

My inquiries as to the precise source of milk supply in the houses I visited seldom elicited definite information; many of the persons interrogated did not know whose goats supplied them, being in the habit of hailing the first goat herd who passed the door.

More particular inquiries as to sources of milk supply in relation with Mediterranean Fever are now being made immediately upon notification, and when the results are tabulated at the end of July, 1905, some definite pronouncement may be possible.

(7) *Uncooked Foods.*—Inquiry was made in a large number of cases with regard to fruits and vegetables, or salads, but nothing tending to incriminate these articles of diet was elicited.

(8) *Infection by Cuts or Abrasions.*—No connection was established between breaches of continuity in the skin and subsequent attacks of Mediterranean Fever. Practically none of the cases I saw had a history of cuts or other abrasions. The only evidence that seems to point in the direction of infection of this kind is the severe incidence of Mediterranean Fever upon patients in the operation ward of the Royal Naval Hospital, Bighi, during 1904, a point which requires further investigation.

The following table gives some idea of the arrangement of the Royal Naval Hospital at Bighi, and the number of patients who developed Mediterranean Fever during 1904, more than 14 days after admission, or less than 14 days after discharge from the hospital.

The chief contributory wards were: C, the operation ward, and D, one of the suppuration wards. Cases were transferred from C to D, if suppuration supervened, and cases were also transferred, when necessary, from D to C. During 1904 seven cases were transferred from C to D, and five from D to C, so that the two wards were in a measure connected with one another. Only one case occurred in E3 or E4, which adjoin the Mediterranean Fever wards and open into them.

Table X.

—	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks	Admissions.	Attacks.
SURGICAL.																										
North block—																										
A (basement), venereal	15	—	10	—	8	—	13	—	27	—	19	—	20	—	8	1	9	—	13	—	21	—	1	1	164	2
C (1st floor), operations	10	1	5	4	8	—	27	—	3	—	—	—	6	—	3	—	3	—	15	1	18	—	—	1	98	7
E (2nd floor), suppuration	8	1	10	—	8	—	—	2	20	—	18	—	13	—	1	—	1	—	—	—	—	—	—	—	79	3
South block—																										
B (basement), venereal	25	—	11	1	11	—	28	1	—	—	—	—	35	—	3	—	—	—	21	1	20	2	3	1	157	6
B2 (basement), ophthalmic	5	—	5	—	1	—	2	—	10	—	4	—	4	—	—	—	—	—	3	—	1	—	1	1	36	1
D (1st floor), suppuration	7	1	8	2	10	—	16	1	7	—	—	—	11	—	7	—	6	—	22	—	19	6	2	2	115	12
F (2nd floor), suppuration	8	—	—	—	—	—	18	—	12	—	10	—	7	—	—	—	—	—	—	—	5	—	3	—	65	0
Officers' cabins	4	—	1	—	4	—	6	—	4	—	35	—	2	—	—	—	—	—	4	—	9	—	1	—	70	0
MEDICAL.																										
East block—																										
1. Mediterranean Fever	—	—	1	—	1	—	2	—	—	—	—	—	2	—	19	—	8	—	25	—	11	—	2	—	71	0
2. Mediterranean Fever	1	—	1	—	1	—	8	—	7	—	8	—	7	—	10	—	—	—	15	—	1	—	—	—	59	0
3. Enteric and scabies	7	—	5	—	4	—	9	—	2	—	—	—	3	—	—	—	—	—	12	—	12	—	1	—	55	0
4. Zymotics	—	—	—	—	8	—	4	—	2	—	3	—	3	—	1	—	—	—	3	—	—	—	—	1	24	1
Officers' cabins	10	—	9	—	12	—	13	—	11	—	6	—	14	—	10	—	6	—	17	—	4	—	1	—	113	0
West block—																										
1. General medical	42	—	56	—	43	—	51	—	35	—	27	—	62	1	18	—	10	—	45	—	40	2	7	—	436	3
2. General medical	1	—	—	—	6	—	17	—	16	—	—	—	25	—	—	—	—	—	—	—	—	—	—	—	65	0
3. Tubercle	5	1	1	—	9	—	1	—	2	—	—	—	—	—	6	—	—	—	9	—	2	—	—	—	35	1
4. Tubercle																										
Officers' cabins																										

PART III.—OUTBREAK OF MEDITERRANEAN FEVER IN THE 2ND BATTALION OF THE ESSEX REGIMENT.

This was the only definite outbreak of Mediterranean Fever that I had an opportunity to observe personally, during my stay in Malta.

The 2nd Battalion of the Essex Regiment arrived at Malta from England on April 29, 1904. With the exception of some details sent to Gozo, the regiment was quartered at Lower St. Elmo Barracks, in Valetta until May 19th, when it went to Pembroke Camp for musketry. It remained at Pembroke Camp until May 28th, and then went on to the camp at Mellicha, whence it returned to Lower St. Elmo on June 10th. It was still at the last-named barracks at the end of September.

The first known cases of Mediterranean Fever in the battalion occurred on June 10th, when two sergeants fell ill, another went sick on the 11th, a corporal and a sergeant on the 14th, and so the cases kept dropping in until, on August 27th, there had been 35 cases, 21 of which were directly connected with the sergeants' mess.

The type of the disease was very severe. Cases 4, 9, and 13 died and others were still in danger at the end of September.

Table XI shows the number of known cases of Mediterranean Fever in the Essex Regiment and the date of onset of the disease in each instance.

Of these 35 cases, occurring in 2½ months, 21 were directly connected with the sergeants' mess; as regards the remaining 14, indicated in the table by a star, there does not appear to have been such connection except in the case of No. 12A. This man, however, returned to Gozo on June 10 to find his wife and child sickening with Mediterranean Fever. The probability of his having been infected by his wife or child, or from the same source as they were, seems stronger than the probability of his having been infected while with the regiment. I have therefore not included him amongst the cases likely to have been infected at the sergeants' mess.

Case 20 was in hospital with simple continued fever during most of the regiment's stay at Pembroke, and he returned to duty at St. Elmo instead of going to Mellicha. He left St. Elmo before the regiment's return, and went to Ghain Tuffieha Camp, and from there to Gozo, where he was attacked by Mediterranean Fever. His illness has therefore no causal relation with the main part of the regiment.

The 21 cases connected with the sergeants' mess form a continuous series of 19 attacks in six weeks, with never more than three or four days' interval. After July 16 there is an interval of 11 days

Table XI.

No.	Date of onset.	Name.	Remarks.
1	June 10	Sergt. H.	
2..	,, 10	,, B.	
3..	,, 11	,, W.	
4..	,, 14	Lance-Sergt. H.	
5..	,, 14	Corpl. J.	Used to go into sergeants' mess for orders.
6..	,, 17	Sergt. L.	
7..	,, 20	Pte. M.	Waiter in sergeants' mess.
* 8..	,, 21	,, H.	No connection shown with sergeants' mess.
9..	,, 23	Sergt. F.	
10..	,, 23	Lance-Sergt. S.	
11..	,, 24	,, B.	
12..	,, 25	,, B.	
*12A	,, 25	,, W. ..	Wife and child had Mediterranean Fever at Gozo, where he rejoined them June 10.
13..	,, 28	,, Y.	
*14 .	,, 29	Pte. F.	No connection shown with sergeants' mess.
15..	July 1	Sergt. P.	
16..	,, 1	,, F.	
17..	,, 4	,, M.	
18..	,, 5	,, Y.	
19..	,, 7	,, K.	
*20..	,, 8	Pte. P.	,, ,, ,, ,,
21..	,, 12	,, M..............	Waiter in sergeants' mess until May 28, 1904.
*22..	,, 15	,, L..............	No connection shown with sergeants' mess.
23..	,, 16	Lance-Corpl. B..	Cleaned men's latrines; was often in sergeants' mess for odd jobs.
*24..	,, 23	Pte. H.	No connection shown with sergeants' mess.
25..	,, 27	,, L.	Waiter in sergeants' mess.
26..	,, 31	Sergt. H.	
*27..	Aug. 5	Lance-Corpl. S.	No connection shown with sergeants' mess.
*28..	,, 10	Pte. W.	,, ,, ,, ,,
*29..	,, 13	,, C.	,, ,, ,, ,,
*30..	,, 13	,, C.	,, ,, ,, ,,
*31..	,, 14	,, C.	,, ,, ,, ,,
*32..	,, 18	,, S.	,, ,, ,, ,,
*33..	,, 26	,, A.	,, ,, ,, ,,
*34..	,, 27	,, W.	,, ,, ,, ,,

without a fresh case, and then follows Case 25 on July 27, and four days later, on the 31st, Case 26. There were no other known cases among persons connected with the sergeants' mess up to the end of September, when I left Malta.

As nearly as could be ascertained there were about 60 persons connected with the sergeants' mess, while there were in all 616 men and officers at Mellieha. Of the 60 persons, 21 were attacked by Mediterranean Fever, while of the remaining 556 persons, 14 only were attacked, and these for the most part at a later period than members of the mess in question.

A short description of the three places occupied by the regiment between April 29, the date of their arrival from England, and the end of September, is as follows:—

Pembroke Camp is the chief musketry camp for the island. It is situated a few miles north of Valetta on the sea shore. The camp is on rocky ground sloping to the sea. The rock is the common calcareous sandstone of Malta, and the intervals between the outcrops are filled by a sandy red loam, which easily pulverises and forms dust.

Mellieha Camp is situated on the bay of the same name, about half-a-mile north of the village of Mellieha, the most northerly village in Malta. The soil in and around the camp is loose and sandy, overlying the upper coralline limestone. The sergeants' mess, a wooden building, is on the edge of the camp, just above a steep sandy slope leading down to the sea.

Lower St. Elmo is a part of the fort which occupies the seaward end of the tongue of land on which Valetta is built. The barracks are below the level of the outer ramparts. The fort is built entirely on the calcareous sandstone.

Both at Pembroke and at Mellieha the regiment was under canvas. An examination of the situation of the tents in which persons attacked by Mediterranean Fever had slept, showed no considerable incidence on any one part of the camp more than on another.

At Pembroke the sergeants messed in a marquee which was equally exposed to the dust with the tents in which the privates lived and ate their food. The marquee stood upon similar soil to the tents, and it was subject to the same conditions with regard to proximity to latrines and urine tubs. It was no more liable to foul air emanations than the tents of the privates. At Pembroke the same latrines (dry earth) were used by the sergeants and by the privates, though a portion was reserved for the former. Complaints were made of offensive smell and of flies at the latrines.

At Mellieha the sergeants' mess hut stood some 40 yards away from the tents of the men. It was a wooden building, raised from the ground on posts, and protected from dust by windows. Built on to it were two water-closets, which were not used during the regiment's stay, because they were said to be out of order. These closets were directly connected with the sergeants' mess room by a louvred ventilator. I found after inquiry on the spot, that these water-closets had become unsealed owing to evaporation. It was therefore possible for sewer air to escape into the mess room from the whole length of sewer below the closets, and from the septic tank to which this sewer conveyed the sewage of the camp. There were separate latrines (water carriage) for the sergeants and the privates at Mellicha; no complaint of smell or nuisance was made as regards either set of latrines.

At St. Elmo the sergeants' mess was situated on a site elevated some 30 feet above the barrack yard across which it faced the men's barrack rooms, at a distance of 40 or 50 yards. The mess was approached by a path seldom used for any other purpose, and the latrines were on the same level as the mess room, about 10 yards distant from it. I found no fault with these latrines other than the faults inherent to their pattern, which I have already discussed; but the latrines for privates in the same barracks were insufficiently flushed and most offensive.

No duty could be heard of which was likely to bring the sergeants of the regiment together into one place, except that of marking at the butts. (There were butts at Pembroke, but not at Mellicha, or St. Elmo.) There were, however, as many corporals and privates employed at the butts as sergeants, yet there was no special incidence of Mediterranean Fever on the former as there was on the latter.

The only places frequented by sergeants, but not by privates, were, at Mellicha and St. Elmo, the sergeants' mess and latrines, at Pembroke, and the sergeants' mess.

The sergeants who were attacked by Mediterranean Fever seem to have been infected roughly in proportion to the amount of time spent in the mess. The married sergeants would frequent the mess at Pembroke and Mellieha equally with the unmarried ones, while at St. Elmo they would spend more of their time at the married quarters. Twenty out of 51 sergeants who frequented the mess at all three places were married. Six of them were attacked before June 25, of whom three were married (the presumption being that cases before the 25th were infected at Mellicha or Pembroke), while of the remaining 12 cases, infected presumably at St. Elmo, only three were married. The number of cases before the 25th is, however, too small to allow of any great importance being attached to the increased incidence on married sergeants before that date.

Supposing, however, that the sergeants' mess, including, at Mellicha and St. Elmo, the sergeants' latrines, afforded the conditions for contracting infection, the question arises as to whether the mess at Pembroke, that at Mellicha, or that at St. Elmo, was chiefly concerned.

The first cases occurred on the 14th day after the regiment left Pembroke. This allows time for an incubation period consistent with the supposition that the disease was contracted at Mellicha, and to a corresponding extent tends to exculpate Pembroke, though it remains possible, of course, that the first few cases became infected at Pembroke. At Mellicha there were circumstances which differentiated the conditions of life at the sergeants' mess from the conditions obtaining in the camp generally, but at Pembroke the same kind of difference did not exist. Some such differences as those obtaining at Mellieha deserve attention in attempting to account for the enormous excess of incidence upon persons connected with the sergeants' mess. Upon the whole, I think it is not likely that the sergeants' mess at Pembroke was seriously, if at all, concerned in the spread of the fever in the regiment, and that it is likely that the cause of the outbreak operated first of all at Mellieha. It would appear certain, however, that the sergeants' mess at St. Elmo had later on a share in spreading the infection, because if we were to suppose that infection was spread only at Mellieha, the average incubation period for Cases 13, 15, 16, 17, 18, and 19, would amount to at least 23 days, and to much more if Cases 21, 23, 25, and 26, were also referred to Mellieha. Although very long incubation periods have occasionally been reported, yet a succession of cases having so lengthened an incubation as the above, seems to me very improbable. I refer here only to the cases connected with the sergeants' mess, the other 13 cases occurring as they did most of them later on, and amongst over 500 men, did not show an incidence much greater than is to be expected under ordinary circumstances in Malta.

Food and Drink.—Bread, water, and milk came to sergeants and privates from the same sources. Butter, fruit, vegetables (salads, tomatoes, etc.), were eaten by both. Mineral waters were drunk by both, but those drunk by the sergeants were said to be made from distilled water, while those supplied to privates were not.

More precise inquiries were made amongst the members of the sergeants' mess and persons connected with it, including those of them who were ill with Mediterranean Fever.

Water.—Inquiry was made of 52 men connected with the sergeants' mess, including 19 of those attacked by the fever, as to water drinking. Cases 5 and 23 were not included because they neither ate nor drank in the sergeants' mess. Thirty-one men never drank water, and one other man only drank it on one occasion, and may for practical purposes be considered a non-water drinker. Of these 32, 11 were attacked (34·4 per cent.). Eleven men seldom drank it, and seven of these were attacked (63·6 per cent.). Nine men habitually drank water, and one was attacked (11·1 per cent.). Non-water drinkers then were attacked at the rate of 34 per cent., while water drinkers (habitual and occasional) were attacked at the rate of 40 per cent. On the other hand, occasional water drinkers were attacked nearly six times as severely as habitual water drinkers. The 11 occasional water drinkers drank it only when employed at the butts, when they obtained it from their water bottles. The habitual water drinkers also drank at the butts, in the same way, water from a like source.

Milk.—As result of inquiry made of 58 men connected with the sergeants' mess, it appeared that 3 drank unboiled milk by itself, and that 1 of them was attacked (33·3 per cent.); while of 55 men who did not drink unboiled milk by itself, 17 were attacked (30·9 per cent.). Case 4 was too ill to be interrogated, and is consequently excluded.

Milk with tea, coffee, or cocoa, was taken by all except three men. None of these three were attacked.

Mineral Waters.—Two out of 59 men interrogated did not drink mineral waters. One of these two was attacked.

Beer.—Of 59 men interrogated, it was ascertained that 52 took beer, and 17 of them were attacked (32·7 per cent.); while of 7 that did not take beer, 2 were attacked (28·6 per cent.).

Raw Vegetables (tomatoes, salads, etc.) were eaten habitually by 42 men out of 59, seldom by 9 men, and never by 8 men. Of the 51 who ate raw vegetables 14 were attacked (27·5 per cent.), while of the 8 men who did not eat them 5 were attacked (62·5 per cent.). Of the 14 cases among eaters of raw vegetables, 12 occurred among the habitual consumers and 2 among the occasional consumers.

Fruit.—Uncooked fruit was eaten habitually by 38 men out of 58, seldom by 13 men, and never by 7 men. Ten of the 38 who eat fruit habitually were attacked (26·3 per cent.). Four of the 13 men who seldom eat fruit were attacked (30·8 per cent.), and 5 out of the 7 who never ate it were attacked (71·1 per cent.).

Bread and Butter were partaken of by all from a like source.

It cannot be said that any one of the foods or drinks inquired about is incriminated by the above details, nor can there be much doubt that if any of the foods or drinks had been largely concerned in spreading the disease, the fact would have appeared. There is a slightly greater incidence upon those who drank water, but not sufficient, in face of the small numbers dealt with, to found any conclusion upon.

Bathing.—Inquiry was made as to bathing, because it has frequently been suggested that Mediterranean Fever might be caused by bathing in sewage-polluted waters. At Mellieha the sewage from the camp is discharged into the shallow waters of the bay, after passing through a septic tank, and at St. Elmo, situated as it is on the point separating the Grand and Quarantine harbours, there is considerable pollution of the water by sewage. Out of 64 men interrogated, 58 bathed and 19 were attacked (32·8 per cent.), while of 6 men who did not bathe, 2 were attacked (33·3 per cent.).

Personal Infection.—The question of direct personal infection from man to man was considered. This may have occurred in the mess-room, but if so, why did it not also occur outside from sergeants to men? unless, indeed, it happened that infection was largely conveyed from man to man by means of spray thrown into the air in the act of speaking or coughing. This method of infection would no doubt be favoured by the still air of the mess room, and by the propinquity therein of the sergeants to one another during conversation; it would not be so likely to operate in the open air, nor perhaps in the tents or barrack rooms at night. If direct personal infection, other than through saliva, were the mode of infection in this outbreak, it would have better opportunity for taking effect in the tents and barrack rooms at night than in the mess room. Many of those attacked by Mediterranean Fever slept in tents with other persons not connected with the sergeants' mess. For instance, 7 privates slept in the tent with Case 12 at Mellicha, and 21 privates in the same room with him at St. Elmo. Most of the unmarried sergeants who fell ill at St. Elmo slept in bunks in the room with 20 or more men, yet none of these men were infected. Five cases altogether occurred in persons who had slept in the same tent or room with earlier cases, and 3 of the 5 were connected with the sergeants' mess.

Biting Insects.—In view of the theory put forward by Zammit, inquiry was made of 58 men connected with the sergeants' mess as to whether they had been bitten by mosquitoes or sand flies. It was considered at the time that the answers received would probably be a better index of the toughness or insensibility of the deponent's skin, than of the facts as they really were; nevertheless the results are given for what they are worth. Forty-three men were conscious of having been bitten, and 7 of them were attacked by Mediterranean Fever (16·3 per cent.); while of 19 who were not aware of having been bitten, 11 were attacked (57·9 per cent.). These figures may be claimed as unfavourable to the hypothesis that biting insects play a part in the transmission of Mediterranean Fever to man. On the other hand, it may be contended that those who were not aware of having been bitten had the more insensible skins, and hence were less likely to take precautions with a view to preventing the insects biting them, and, in consequence, were the more likely to have been bitten. Cases 4, 9, and 13 were too ill to answer this interrogation, and are consequently excluded.

If infection were conveyed by a biting insect, the insect, to fit in with the circumstances of this outbreak, would require to be one which did not bite in bright sunlight, nor in the dark. It was practically only in bright sunlight or in the dark that the sergeants mixed with the men, and if the insect were in the habit of biting under these conditions, the men would have been infected as well as the sergeants. Again, the insect must be one likely to confine itself strictly to one building or marquee, seldom or never wandering 50 yards away, for at Pembroke, Mellicha, and St. Elmo the tents or barrack rooms were within 50 yards of the sergeants' mess.

It may be asked how would the insect be likely to have become infected. Mellicha Camp was occupied from May 3 to June 9 by three different regiments, but no case of Mediterranean Fever is known to have occurred amongst them during their stay or 14 days after. Neither were any cases reported from Mellicha village during this period. The possibility, however, of there having been unrecognised cases of Mediterranean Fever in one of these regiments, or in the Essex Regiment, cannot be disregarded.

It should be noted that non-commissioned officers would provide better opportunity for the spread of personal or insect-borne infection, than would private soldiers. The former are always loth to go to hospital, and usually defer reporting themselves sick until the last possible moment, while the latter generally report at once. In this outbreak, for instance, Case 6 did not go into hospital until July 15, although he became ill on June 17.

The only biting insect, of which I am aware, that comes at all near fulfilling the conditions which this outbreak seems to require is the female *Stegomyia fasciata.* There is, however, at present, wide divergence in the views of various observers as to her flight and habits of biting. It would be remarkable if so short a distance as 50 yards proved an insuperable barrier for a winged insect, even for one which, like the Stegomyia, is generally supposed not to wander far. Specimens of the Stegomyia were to be found at the time at Mellieha and St. Elmo, but they were also to be found at Valetta Station Hospital into which all the cases were removed. In this hospital Mediterranean Fever patients were separated from other patients only by a partition 9 or 10 feet high, in a ward more than 20 feet high, and mosquito nets were not in general use, and yet it does not appear that other patients became infected specially at that time.

Latrines in Connection with the Outbreak.—In view of Horrocks' discovery that the *Micrococcus melitensis* is excreted in the urine, and the possibility that it is also excreted in the fæces, the question arises, supposing that infection were spread by the sergeants' mess at Mellieha and St. Elmo, was it spread principally by way of the mess room, or by the latrines? The latter, it will be remembered, were separate from those of the privates both at Mellieha and at St. Elmo. I am not now considering the disused water-closets at Mellieha. Both the latrines and the mess room were used by everybody connected with the sergeants' mess, except Cases 5 and 23, so that it is difficult to find any evidence to incriminate the one place as against the other. It can be said, however, that it is difficult to imagine an infection inherent to the mess room yet not likely to be conveyed directly from man to man outside, while if the infection be supposed to be inherent to the latrines and of excretal origin, the difficulty is not nearly so great: infected dust, due to the pattern of the latrines, or infection of the hands and thence the mouth or nose for instance. Against the possibility of the latrines having been principally concerned in the spread of infection is the following negative evidence which is not of sufficient weight to be at all conclusive:—One and the same man attended to the flushing and cleansing of the sergeants' latrines both at Mellieha and St. Elmo, and he was not attacked by Mediterranean Fever. Cases 5 and 23 did not use the sergeants' latrines. In addition it may be said that if the first few cases of the outbreak were infected at Pembroke, where the sergeants used a portion of the same latrines as the men, it would be expected that some of the men would have been infected if the latrines were the source of infection. I have, however, already said that I do not think it probable that the early cases were infected at Pembroke, and the man who attended to the sergeants' latrines may have been immune to Mediterranean Fever.*

With regard to the two water-closets through which it was possible that sewer air obtained access to the sergeants' mess at Mellieha, there appeared to be two ways in which they might have contributed to spread the fever: either by allowing infected dust to enter the mess room, or by allowing sewer air to enter, and thus weakening the natural tissue resistance by causing sore throat, or general loss of tone. None of those attacked by the fever, however, complained of sore throat previous to the onset of the fever. As to the infected dust theory, specimens were procured of the dust in the ventilator and on the closet pan, and were injected into monkeys by Horrocks without producing any ill effect. These specimens were, however, very minute, and were procured some weeks after the regiment left Mellieha. But supposing that infected dust from these closets, or from the latrines, were the cause of fever at Mellieha, what then caused the continuance of the outbreak at St. Elmo? Again, if the general tone of the men's health was lowered by the inhalation of sewer air in the mess room at Mellieha, and they were thus rendered specially liable to Mediterranean Fever, their health should have recovered its normal tone at St. Elmo, other conditions being equal, and the outbreak should have ceased, which was not the case.

Septic Infection.—Inquiry was made of those attacked as to whether they had suffered from cuts or boils, or other skin lesions, before the onset of the fever, but in no case was the reply in the affirmative.

Conclusion.—The available evidence is not such as to justify a definite conclusion as to the manner of propagation of Mediterranean Fever in this outbreak.

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* "Carbolic" powder was used as a disinfectant in the latrines from the time of the regiment's arrival in Malta until May 18, when it was discontinued by order of the War Office, on the grounds that it was not a disinfectant but only a deodorant. Its use was resumed by the Essex Regiment on June 20. In view of any question arising as to a connection between the disuse of the "carbolic" powder and the outbreak of fever, a specimen of the powder was examined for me by Horrocks, and he found that a 10-per-cent. solution in urine failed to kill a culture of *M. melitensis* in one hour. I do not therefore think that the use, or disuse of the powder can have had any influence on the potentialities of the latrines to spread infection.

The facts narrated, however, are not without value for the epidemiologist. If they cannot be held to warrant positive assertion of the transmission of the malady by a particular agency, they are at least of service in strongly suggesting the exclusion, in this instance, of certain possible factors, and as regards other such factors, in affording means of considering the relative degrees of probability of their having been concerned with the incidence of the fever.

Regarded in this light, the evidence may fairly be held to indicate that articles of food and drink played no appreciable part in the dissemination of the disease. A like inference is justified concerning the possible influence of conditions associated with bathing, and with inhalation or swallowing of infected dust in the open.

The possibility of the fever having been conveyed by biting insects cannot so readily be dismissed. But a careful review of the facts and conditions adduced under this head does not favour acceptance of the hypothesis that the explanation of this outbreak is to be found in this direction.

The facts reviewed in this report under the heading of direct personal infection are only such as would suggest the transmission of the fever by this agency if the manner of transmission in this instance had been such as almost entirely to limit its operation to the sergeants' mess. I am not, so far, in possession of any facts on the bacteriological side capable of strengthening, or negativing the possibility of transmission of the fever by saliva. I do not know even that the *Micrococcus melitensis* exists in the saliva of patients. It may be said, however, that infection by means of saliva affords a solution of the problem of transmission not inconsistent with the facts in this outbreak, so far as I have been able to discover them; but it must be added that other facts noticed in Part II of this report under the heading "Direct Personal Infection," do not point to the probability of saliva spray having played a part in the spread of infection. (See p. 37 *et seq.*)

There remain for consideration the possibilities of the fever having been transmitted by conditions other than direct personal infection, or conveyance of the disease by biting insects, associated with the latrines of the sergeants' mess, or with the sergeants' mess itself.

Hypothesis that Mediterranean Fever may be a "filth disease," and that the latrines in question became and remained for some time infected by *Micrococcus melitensis*, passed in the urine or fæces of persons using them, would point rather to the latrines having had relation with propagation of the disease than to like relation of the mess itself. Such hypothesis, however, involves considerations that require further investigation, and, without more complete knowledge than is now available, can be no more than tentative.

Besides the condition suggested by this hypothesis, there may be others, at present unknown, which future epidemiological investigation, combined with further acquaintance with the life history and habits of the specific contagion of the malady, may serve to reveal, and which may be found to explain, as regards this outbreak of Mediterranean Fever, the special incidence of the disease upon persons frequenting the sergeants' mess or using their latrines.

These inferences, and the relative degree of probability of each, have relation solely to this particular outbreak of Mediterranean Fever. Even did the evidence point conclusively to one particular agency as being solely concerned with the outbreak, it would not necessarily follow therefrom that such agency would have to be regarded as the only one having concern with the transmission of Mediterranean Fever generally.

PART IV.—GENERAL SUMMARY AND CONCLUSION.

Hampered by a sense of the inaccuracy of the civil notification returns, I have only attempted to draw the most general conclusions from them, except with regard to the seasonal incidence.

The evidence I have been able to collect is not sufficient to lead to any final conclusion. I hope, however, that I have been able to indicate in the course of Part II some directions in which further epidemiological investigations would be likely to prove profitable.

The distribution of Mediterranean Fever amongst the civil population goes to show that, outside certain paved and drained areas, aggregation of persons in one locality, and density of population upon area in a district, favour the spread of the disease. The distribution amongst the garrison depends mainly on the age of the men and their length of service in Malta, new arrivals and young men being more frequently attacked. As regards the Navy, I have only been able to obtain figures for three years. So far as they go, they tend to show that, when a ship is invaded in one year, it is also invaded in each successive year, if it remain on the station.

The incubation period seems, on the data I have been able to collect, to be about 14 days, but further evidence is necessary before a definite conclusion can be reached.

As to the mode of entry of the specific infection into the human body, the facts do not permit of a definite pronouncement. The evidence, so far as it goes, seems to show that food and drink have no marked connection with the spread of the fever. Newly turned earth falls into a like category.

As a whole, the facts do not indicate that dust infection, outside dwellings, or direct personal infection by contact, breath, or saliva, plays an important part in spread of the disease, but there is not evidence to justify the exclusion of any of these factors.

I have been able to collect little evidence either for or against the carriage of infection by biting insects.

The facts with regard to infection by means of excretal pollution of the hands, the food or the dust in houses, so far as I have been able to deal with them, are suspicious, but they are not sufficiently strong to justify any conclusion.

Some reform of the notification system in Malta is necessary before epidemiological investigation can be expected to produce the best results. In addition, facts must be collected and recorded immediately after their occurrence by competent observers. Such work cannot be adequately performed by the sanitary inspectors as at present trained in Malta.

I have endeavoured to provide for the immediate record of a certain number of facts in relation to cases of Mediterranean Fever during the year ending July 31, 1905, amongst the civil population, and in the Services. With regard to the former, I fear that laxity of notification will prove a stumbling block. I regret that an urgent invitation to the Maltese medical men to forward blood samples to the public health laboratory for confirmation, did not meet with the response I expected.

I hope, however, that the facts now being recorded may prove useful in the consideration of some points.

In the meantime, I am still in process of receiving information from Malta which I have requested, as I found it necessary, and I should prefer to await its arrival and the consideration of the facts for the year ending July 31, 1905, before making any recommendations.

I have to thank the following gentlemen for much help and information given me in the course of this inquiry :—Deputy-Inspector Cox, R.N.; Fleet-Surgeon Bassett-Smith, R.N.; Staff-Surgeon Gilmour, R.N.; Colonel Wolesley, R.A.M.C.; Lieutenant-Colonel Rhodes, R.A.M.C.; Captain Kennedy, R.A.M.C.; Lieutenant-Colonel Adair, R.E.; Lieutenant-Colonel Winter, Director of Supply and Transport; and Major Boyce, D.S.O.; the Honourable A. Gatt, Superintendent of Public Works; the Honourable A. Micallef, Comptroller of Charitable Institutions; Mr. Cartwright-Reed, Admiralty Superintendent of Works; the Rev. Father Dobson, S.J., and the medical officers of health of Malta and Gozo.

ON THE SAPROPHYTIC LIFE OF THE *MICROCOCCUS MELITENSIS.*

By Fleet-Surgeon P. W. Bassett-Smith, R.N.

In compliance with suggestions made at the Sub-Committee Meeting of November 27, 1904, I have, at Haslar, carried out independently, during the last three months, some experiments relating to the vitality of the *M. melitensis* outside the body, with special reference to the infection of the soil, clothing, sea and tap-water, through the agency of infected urine. During this time I have not myself been able to isolate the *M. melitensis* from the urine of any clinical case in the wards (most of them being chronic, with relapses), though it was often present in the peripheral blood, and have, therefore, had to employ urine artificially infected; from the experiments it was apparent that the grosser the infection the longer could the organism be recovered from the material infected.

Some check experiments were also made with broth cultures as a means of infection, though in all cases these had been previously cultured for a certain time in human urine, which apparently did not decrease the vitality of the *M. melitensis.*

In proving the results of these experiments, as to purity of cultures, the following tests were carried out:—

1. Microscopical examination for morphological characters.
2. Alkaline reaction with litmus broth and milk.
3. Inability to stain by Gram.
4. Reaction with known serum of a Mediterranean Fever case.

Vitality of the M. melitensis *in Urine.*

Series 1.—The urine employed was that taken from Mediterranean Fever cases, which had been proved not to contain the *M. melitensis*, and had been sterilised on three days, but not otherwise treated.

No. 1.—A considerable quantity of a surface culture on agar of *M. melitensis*, originally obtained from Netley, in 1901, was emulsified with 10 c.c. of sterilised urine from a Mediterranean Fever case. It was kept at a temperature of 22° C.

This was subcultured successfully daily up to the 18th, after which it was not recovered.

No. 2.—Equal quantities of a five day old broth culture of *M. melitensis* and sterilised Mediterranean Fever urine, were mixed and subcultured daily on agar. The organisms gradually died out, and were last detected on the 14th day.

No. 3.—Strongly alkaline urine was infected from an agar culture of *M. melitensis* of three days' growth. Here the organisms more quickly died out, being last recovered on the 12th day.

No. 4.—Sterilised urine of a Mediterranean Fever case was infected from an agar culture, which had been previously passed through urine and sea water. In this case it was not recovered from the urine later than the 9th day. The urine was then very alkaline, equal to standard deci-normal soda sol.

No. 5.—Very slightly alkaline sterilised urine of a Mediterranean Fever case was infected from an agar culture, which had been previously passed through tap-water and urine.

In this the *M. melitensis* was regularly recovered, growing normally up to 41 days, the urine infected remaining perfectly clear, and was only slightly alkaline when the organism died out.

No. 6.—Faintly alkaline sterilised urine, rich in urates, of a case in the ward was infected by an agar culture derived from a sea-water one, inoculated from an artificially infected urine.

In this the *M. melitensis* again retained vitality for an exceptionally long period, viz., 39 days, the last subculture reacting normally in all respects.

Viability in Sea-Water.

Series 2.—These were made with ordinary sea-water taken from the harbour, sterilised, and, after inoculation, placed in the 22° C. incubator, and evaporation prevented.

No. 1.—Ten c.c. of sterilised sea-water was infected from a five-day old agar culture of *M. melitensis* derived from artificially infected urine. In the subcultures the colonies gradually became fewer, the last being found on the 26th day.

No. 2.—Ten c.c. of sterilised sea-water was infected with 1 c.c. of seven-day old broth culture of *M. melitensis*, which had been derived from artificially infected urine. From this the last successful subculture was made on the 21st day, when the tube was accidentally broken.

No. 3.—Ten c.c. of sterilised sea-water was infected with 1 c.c. of slightly alkaline urine strongly infected with *M. melitensis* derived from artificially infected urine, that is, two passages through urine; subcultures gave abundant growth until 30 days, when it appeared to die out rapidly, the last being obtained on the 34th day.

Viability in Tap-Water.

Series 3.—These were made from sterilised tap-water of the laboratory after inoculation, being kept in 22° C. incubator.

No. 1.—Ten c.c. of sterilised tap-water was infected from an agar culture of *M. melitensis* derived from artificially infected urine. The last successful subculture was obtained on the 23rd day.

No. 2.—Ten c.c. of sterilised tap-water was infected with 1 c.c. of a seven-day old broth culture of *M. melitensis* derived from artificially-infected urine. Growth was obtained up to the 18th day, when the tube became contaminated.

No. 3.—Ten c.c. of sterilised tap-water was inoculated with 1 c.c. of slightly alkaline urine freshly infected with *M. melitensis* which had been grown in urine. Growth was obtained abundantly until the 26th day, the last being obtained on the 30th.

Viability in Fabric which had been Infected, and Dried in Hot Incubator.

Series 4.—Small squares of flannel fabric were used. These were soaked for certain periods in the culture, drained, and then dried slowly in the hot incubator.

No. 1.—The squares of fabric were immersed for 24 hours in a broth culture of *M. melitensis*, then dried as above stated. One of these was removed every three days, placed in broth, and finally subcultured on agar. Recovered for 37 days.

No. 2.—Immersed for a quarter of an hour in infected urine. Recovered for 7 days only.

No. 3.—Immersed for half an hour in grossly infected urine. Recovered for 15 days.

No. 4.—Squares soaked for 24 hours in urine (Series 1, No. 5) on 10th day of growth. *M. melitensis* recovered for 26 days. The squares soaked became discoloured and stiff from impregnation with urinary constituents.

No. 5.—Squares soaked in infected sea-water for 12 hours. No growth obtained on the 7th day.

Viability in Artificially Infected Dust.

Series 5.—Fine bath brick dust was sterilised, and then soaked for one hour in infected media, drained, and dried in hot incubator. Subcultures were regularly made from this with litmus broth, and finally from this agar cultures, and tested for purity.

No. 1.—Fine oolitic dust infected for one hour with five-day old broth culture, derived from artificially infected urine. *M. melitensis* recovered for 25 days.

No. 2.—As above. *M. melitensis* recovered for 26 days.

No. 3.—Oolitic dust infected with seven-day old broth culture derived from infected urine. Growth abundant and typical. Recovered up to 36 days.

No. 4.—Oolitic dust soaked in slightly alkaline sterilised urine, grossly infected with *M. melitensis.* Growth was recovered for 30 days.

No. 5.—Oolitic dust soaked in urine in which *M. melitensis* was growing feebly. Not recovered on 3rd day, or any date after.

Series 5A.—Road dust with vegetable and other *débris* collected and thoroughly sterilised, and tested by control cultures. Treated in similar manner to oolitic dust.

No. 1.—Road dust infected by soaking in five-day old broth culture of *M. melitensis* derived from artificially infected urine. Recovered for 44 days.

No. 2.—Road dust soaked in urine strongly infected with *M. melitensis.* Recovered for 16 days.

No. 3.—Road dust soaked in urine in which *M. melitensis* was growing feebly. Not recovered on 3rd day, or any subsequent date.

No. 4.—Road dust infected with urine and broth culture of *M. melitensis* in equal parts. Recovered for 8 days only.

Table of Results of Vitality of the *M. melitensis* outside the Body.

Medium tested.	Source of supply.	Number of days on which the *M. melitensis* was recovered.
Urine, sterilised	Agar culture	9
	,,	12
	,,	18
	,,	39
	,,	41
	Broth culture	14
Sea-water, sterilised	,,	21 (tube broken)
	Agar culture	26
	Infected urine	34
Tap-water, sterilised	Agar culture	23
	Broth culture	18 (contaminated)
	Infected urine	30
Fabric, infected and dried	,, ¼ hour	7
	,, ½ ,,	15
	,, 24 hours	26
	Broth culture 24 ,,	37
	Sea-water 12 hours	Less than 7
Dust, oolitic, infected and dried	Broth culture	25
	,,	26
	,,	36
	Infected urine (strong)	30
	,, (weak)	Under 3
Road dust, infected and dried	Broth culture	44
	Infected urine (strong)	16
	,, (weak)	Under 3
	Urine and broth	8

OBSERVATIONS ON THE VIRULENCE OF *MICROCOCCUS MELITENSIS* FOR THE GUINEA-PIG.

By J. W. H. Eyre, M.D., F.R.S. Edin., Lecturer on Bacteriology in the Guy's Medical and Dental Schools, Bacteriologist to Guy's Hospital, etc.

Summary.

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The Pathogenic Action of M. melitensis.

The degree of virulence possessed by *M. melitensis* for such rodents as the rabbit and guinea-pig is naturally exceedingly low, and in order to produce a fatal infection in these animals, it is necessary to introduce enormous numbers of cocci subcutaneously or intraperitonally; even then the infection follows a protracted course, and weeks or even months may pass before death takes place.

The majority of the animal experiments by early observers was carried out upon the monkey, an animal which, as originally shown by Bruce,* and afterwards by Hughes, can be easily and certainly infected, chiefly for the reason that attempts to produce fatal infection in the usual laboratory rodents (the rabbit, guinea-pig, and mouse) were for the most part unsuccessful, certainly no appreciable increase in virulence could be demonstrated.

In 1898, however, Durham† applied the method Catani had used to raise the virulence of the influenza bacillus to *M. melitensis*, and was able to show that the natural resistance of both the rabbit and the guinea-pig was much more readily overcome if the Micrococcus was introduced directly into the brain substance. Further, by a short series of intracerebral passages, he succeeded in slightly raising the virulence, as will be seen from an inspection of the accompanying table, which is compiled from his paper.

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* Bruce, "Sur une nouvelle forme de fièvre rencontrée sur les bords de la Méditerranée, 'Annales de l'Institut Pasteur,' vol. 7, 1893, pp. 289—304; 'Practitioner,' 40, 1888, p. 241; Hughes, "Investigations into the Etiology of Mediterranean Fevers," 'Lancet,' vol. 2, 1892, p. 1265.

† Durham, "Some Observations on the *Micrococcus melitensis*" (of Bruce), 'Journ. of Path. and Bact.,' vol. 5, December, 1898, pp. 377—388.

Table I.

Animal.	Inoculation.	Dose.	Mode of infection.	Result.
1. Rabbit....	Large quantity of cocci from agar plate suspended in 4 c.c. of a 4-day broth culture	0·5 c.c.	Intracerebrally	Died 4th day.
2. Guinea-pig	—	0·3 ,,	,,	Ill from 3rd to 10th day; recovered. Killed at 4 months.
4. Guinea-pig	5-day agar culture from Rabbit 1	1·5 loop (3 mgrms.)	,,	Died 6th day.
5. Guinea-pig	Agar culture from Guinea-pig 4	1 loop (2 mgrms.)	,,	Died 4th day.

The rise in virulence for the guinea-pig resulting from one passage through the rabbit is remarkable; but it will be seen that the additional passage through Guinea-pig 4 did not cause any appreciable effect—the fact that a slightly smaller dose was fatal to Guinea-pig 5 might be readily explained on the ground of that animal's greater susceptibility, *e.g.*, a younger or a smaller animal—a contention which is supported by the observations that in subsequent inoculations 2 and 1 loop (*i.e.*, 4 and 2 milligrammes) were fatal respectively in four and six days.

This feeble virulence for the guinea-pig combined with the tardy growth of *M. melitensis* upon artificial media renders it a matter of some difficulty to estimate the amount, or indeed the presence of protective bodies in the serum of animals treated with cultivations of the organism—so troublesome a process in fact, that after attempting, during the early part of last year, to prepare an anti-serum from the goat, I suspended my experiments in favour of an inquiry into the possibility of exalting the virulence of the micrococcus.

In view of the results of Durham's observations, I decided to limit my endeavour to exalt virulence for the guinea-pig to the intra-cerebral method of inoculation, and to employ, at first, one strain only of the *M. melitensis* in my experiments. The result was distinctly encouraging, for after rather more than a score of passages a very considerable access of virulence was obtained.

Before giving the details of these passages, a few points concerning the organism used and the methods followed may be of interest.

Organism Employed.—M. melitensis "*No.* 5."

Origin.—Isolated from the pus during life, and subsequently from the spleen (*post-mortem*) of a fatal case of subdiaphragmatic abscess* occurring in Guy's Hospital during October, 1903.

Morphology and Cultural Characters quite typical.

Initial Virulence for the Guinea-pig.—When first isolated, three entire four-day agar cultivations (*vide infra*) emulsified in 0·4 c.c. sterile saline solution, injected intracerebrally, were required to cause death—the fatal termination ensuing about 25 days after inoculation.

Medium Used for Growth of Virulence Cultures.

Previous experiments of my own, no less than the experience of other observers, show that fluid media are quite unsuited for the growth of, what I may term "Virulence Cultures." In the first place, growth in, for example, nutrient broth is extremely slow, and does not reach its maximum until the 6th to 8th day: then, too, the cranial capacity of the guinea-pig is small, and if the dose of culture exceeds or even amounts to 0·5 c.c., either some of the inoculated fluid at once escapes, or severe pressure symptoms supervene, and the animal dies within a few minutes.

A cultivation upon a solid medium, on the other hand, affords the opportunity of concentrating a large amount of the infective material in a bulk sufficiently small to ensure retention of the entire dose within the cranial cavity, without causing the exhibition of pressure symptoms, by scraping off large numbers of cocci and emulsifying in minute quantities of sterile saline solution.

Some observations upon the cultural characters of *M. melitensis* made during last summer by the writer in conjunction with Surgeon Duncan, R.N., showed that upon ordinary nutrient agar (prepared and standardised to +10, according to the method and scale I have described elsewhere)† *M. melitensis* in subcultivations would develop colonies visible to the naked eye in from 24 to 30 hours at 37° C., and would attain the maximum development in from 72 to 96 hours.*

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* Eyre, "A Case of Subdiaphragmatic and Hepatic Abscess consecutive to Mediterranean Fever," 'Guy's Hospital Reports,' 59, 1905, pp. 207–216.

† Eyre, "Standardisation of Nutrient Media," 'Brit. Med. Journ.,' 2, 1900, p. 921, and 2, 1901, p. 788.

I therefore decided to employ this medium in the form of "slant" tube cultures, filling the medium in quantities of 10 c.c. into tubes specially selected to secure uniformity of size, and always slanting the medium at about the same angle in order to obtain approximately equivalent areas for growth in each culture.

Preparation of Inoculum.

Tubes were inoculated from the spleen of one guinea-pig which had succumbed to intracerebral infection for inoculation into the brain of the next animal of the series, and after 24 hours' incubation at 37° C. were examined naked eye, and microscopically by means of smear preparations. As a rule at this age no definite colonies could be distinguished naked eye, although the inoculated surface of the medium presented a ground-glass appearance, and film preparations always yielded abundant evidence of growth.

After the preliminary examination, a sterile platinum loop was introduced into the tube, moistened in the water of condensation, and then gently rubbed all over the slanted surface of the medium. As the result of this manœuvre, by the third or fourth day the medium was covered with a luxuriant growth, affording ample material for inoculation.

Method of Measuring the Dose of Inoculum.

The terms "entire culture," "half a culture," etc., as applied to dosage have little to recommend them on the score of exactitude, therefore the more accurate method of measurement by "loops" evolved by the late Dr. Washbourn and myself for the estimation of the virulence of the pneumococcus was utilised in the experiments. Briefly, this method consists in using a platinum loop accurately calibrated by weighing experiments; filling it carefully with the culture, and then emulsifying its contents in a definite measured quantity of broth, and using for the inoculation portions of this emulsion, representing fractions of the original loop. The special loop I use is the one originally made for pneumococcus work; its holding capacity had already been estimated to equal 0·5 milligramme of a 24-hour-old blood agar cultivation of pneumococcus; and when re-calibrated for 72 to 96-hour-old agar cultures of *M. melitensis* it was determined to have an identical capacity.

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* At the same time I am not prepared to state absolutely that +10 is the *optimum reaction* of the medium to be employed for this purpose, until some experiments that are being carried out now are completed. Still this reaction is undoubtedly close to the optimum, so that in the absence of more definite knowledge I did not feel inclined to deviate from it.

Further, by plating out various fractions of a loopful of 72 to 96-hour-old agar cultivation and enumerating the colonies that subsequently developed, an approximate estimation was obtained of the number of cocci per loopful—that is to say, contained in 0·5 milligramme cultivation.

The average determined from a large series of experiments worked out to 1,250,000,000 cocci per loopful.

Now as in some of the preliminary inoculations more than one "slant" tube culture was required to produce a fatal infection, several observations were made to determine the average number of loopfuls per cultivation. After many trials this was found to be 25; and all the doses in the detailed table of inoculations are calculated as "loops," and so recorded—although in the first few inoculations the figures can only be regarded as approximately correct, for these doses were not measured accurately, on account of their size.

Method of Inoculation.

As the intercranial method of inoculation is not amongst those most commonly practised, some details of the *technique* I adopted may be of interest.

The guinea-pig is first fully anæsthetised by means of a mixture of alcohol, chloroform, and ether, in the proportion of 1 : 2 : 6 (A_1, C_2, E_6), administered on a piece of absorbent cotton-wool placed either in the corner of a folded towel, or in the bottom of a small conical glass beaker.

The animal is then fastened down to the operating table, or firmly held by an assistant, and the hair of the scalp moistened with a solution of soft soap in 2-per-cent. lysol, which, with the help of hot water and cotton-wool, is worked up into a lather. The entire scalp, from the occipital protuberance to the root of the snout, is shaved, and finally washed with warm lysol solution.

A median incision commencing over the occiput and running forwards for about 2 cm., is made through the skin and subcutaneous cellular tissue, and retractors, secured by the assistant, used to hold open the wound. The periosteum is next divided along the entire line of the skin incision, then raised with a blunt dissector and also secured by the retractors.

A small nasal trephine (Curtis's), having a tooth-cutting circle of 6 mm. diameter,* is attached to a dental engine, and a small disc of bone removed from the left parietal bone; this trephine hole is cut well to one side of the median line to avoid injuring the superior longitudinal sinus, a mishap which gives rise to troublesome hæmorrhage.

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* This instrument has been adapted for me by Messrs. Down Bros. by the addition of an adjustable collar guard, secured by a screw, to prevent laceration of the dura mater or brain substance.

A hypodermic syringe provided with a fine needle is used to inject the measured dose of cocci, and some little manipulation is found to be necessary to ensure that the animal receives the entire dose. The injection may be made into any portion of the brain substance, or into the subdural space. Usually I inject into the left cerebral hemisphere, rarely into the frontal region. I avoid entering the cerebellum solely because muscular tremors and twitchings of the entire body are thereby induced which last for some minutes and interfere with the suturing of the skin wound.

The disc of bone is replaced or not, according to circumstances. If the injection appears to have caused any appreciable rise in the intracranial pressure, as indicated by protrusion of brain matter and meninges into the trephine circle, I do not replace the bone; otherwise I do. The periosteum is now readjusted as nearly as possible to its original position, and the skin incision closed by means of a continuous suture of either linen or silk, then sealed with flexile collodion. A dressing of sterile absorbent cotton-wool is fixed over the wound with more collodion, and the animal allowed to come round from the anæsthetic. Although the description is lengthy, the operation occupies but little time; given one assistant to attend to animal and the anæsthetic, 10 minutes will suffice from the commencement of the anæsthetisation to the return of the guinea-pig to its cage.

Passages to Exalt Virulence.

For the sake of brevity and clearness, I have tabulated the details of such of my inoculation experiments* as are pertinent to the present inquiry (*vide* Table II), and in this connection I must distinctly point out that my object was in no sense to determine the *minimal* fatal dose of that particular strain of *M. melitensis* I employed, for I take it the minimal fatal dose is the smallest dose which will cause a fatal specific infection after the lapse of no matter how lengthy a period.

Such an inquiry would have required the expenditure of more time than is at the disposal of any one man, for Durham has already shown, and I can fully confirm his observations, that an experimental animal may die of *M. melitensis* infection at a period as far distant as three months from the date of inoculation.

My intention was rather to so raise the virulence of the coccus for the guinea-pig that a comparatively small, and accurately measurable dose, should consistently cause death within a definite period of seven days; and in tabulating my results I have been guided by this principle, and have restricted myself as far as possible to the inclusion of those animals in any given series that succumbed within seven days to the smallest dose. For instance, Guinea-pig 12 was in fact labelled (B) of a series of three inoculations performed on the same day with different doses of the same culture. (A) received 25 loops, and died in 21 hours; (C) received 0·1 loop, and died in 12 days; therefore (B), having received the smallest dose (1 loop) that was fatal within the prescribed period, alone appears in the table.

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* Eyre, "The Preparation of Nutrose Agar," 'Trans. Path. Soc.,' 55, 1904, p. 91.

From the details shown it will be seen that after 21 passages through guinea-pigs the virulence of a particular strain of *M. melitensis* originally so feeble that 75 loops (or 37·5 milligrammes) of culture required 25 days to kill a 380-gramme guinea-pig, has been so exalted that two loops (or 1 milligramme) of culture is sufficient to kill a 590-gramme pig in about 24 hours, whilst 0·5 loop (or 0·25 milligramme) will kill a 350-milligramme pig within five days.

Course of the Infection.

The course of the infection of the guinea-pig by *M. melitensis* may be conveniently considered under two separate headings: (1) Acute, and (2) Chronic, according to whether death is caused in a few hours or days, or is delayed for from one week to two or three months.

Acute Infection.—An animal dying within a few days of intra-cerebral inoculation with a moderate dose of a highly virulent cultivation or a large dose of a less virulent one, supplies the type for this form of *M. melitensis* infection.

A short incubation period varying in duration from 12 to 24 hours follows the inoculation, and during this time the animal appears to be in normal health and eats well, although the progressive loss of weight which is the marked characteristic of the infection begins within a few hours of inoculation. A stage of irritation follows the incubation period, and lasts for about 24 hours; it is marked by convulsions, at first localised and produced in response to direct stimuli; afterwards becoming generalised, tonic in character and occurring at frequent and irregular intervals; progressive muscular weakness is a marked feature of this stage, throughout which the animal is obviously ill and stupid, and refuses food. The stage of irritation passes gradually into one of coma, with paresis or paralysis, affecting first the hind legs, afterwards involving the fore limbs also. Handling or even touching will at first rouse the animal and provoke general convulsions; later, the guinea-pig falls on its side, becomes insensible, and, in fact, appears moribund. In this condition, however, the animal may remain for 24 or even 36 hours, and during the latter part of this period no rectal temperature can be recorded by the ordinary clinical thermometer, for 32° C. is hardly ever exceeded. Death is sometimes preceded by convulsions, but usually no such warning is given. To give a concrete illustration of the train of symptoms and *post-mortem* findings in these acute infections I cannot do better than cite in full the clinical history of and autopsy on guinea-pig 19 (*vide* Table II), which is quite typical. Incidentally, I may mention that this case would serve equally well to illustrate the course of infection in the rabbit.

Guinea-pig 19. Sex ♂. Weight 450 grammes. Temp. 38° C.

11.2.05	4 P.M.	A.C.E. was administered, and a 6 mm. trephine circle was cut from left parietal bone. Four (4) loops of 3-day old agar cultivation of *M. melitensis* from spleen of Guinea-pig 18, emulsified in 0·2 c.c. sterile saline solution, injected into substance of left cerebral hemisphere. Disc of bone replaced, also periosteum, skin incision sutured, and wound dressed with collodion and cotton-wool.
	12 P.M.	Appears quite well. Has eaten well since inoculation.
12.2.05	9 A.M.	Is huddled up in one corner of cage; is not eating; hair dull and standing on end; is obviously ill. Has lost 60 grammes in weight.
13.2.05	,,	Condition apparently unchanged. Has lost a further 60 grammes in weight.
	10.15 A.M.	Is now grinding teeth, moves slowly, and, if turned on back, rights itself very slowly.
	10.30 A.M.	Generalised spasms result if touched; convulsive movements occur from time to time even in the absence of obvious stimuli.
	1 P.M.	Much worse—marked paresis of hind quarters.
	2 P.M.	Convulsive "circus" movements occur from time to time—the animal dragging itself round "clockwise" by means of its fore paws.
	9 P.M.	Quiet in corner of cage; breathing laboured.
14.2.05	9 A.M.	Apparently unconscious, lying on side; if placed on legs is unable to stand, and falls down after slight feeble convulsive movements, once more becomes still. Breathing shallow and slow.
	11.30 A.M.	Condition unaltered.
	11.45 A.M.	Still in same position as when last looked at. Is now dead.

Post-mortem Examination.

Scalp Incision.—Scalp wound healthy in appearance, lips of incision healing by primary union; no signs of pus visible in wound; no stitch abscesses.

Subcutaneous tissue occupied by œdematous and jelly-like exudation marked here and there with small hæmorrhages.

Bone.—The disc of bone is firmly fixed *in situ* by serous exudation, in which the periosteum is also involved. On raising the disc of bone no protusion of meninges, etc., occurs.

Cranial Cavity.—(This is most conveniently reached without damage to the structures beneath by reflecting skin and periosteum from over the entire cranial vault; then, with a red-hot iron, thoroughly searing the bone, which when seared and dry can easily be broken up with a pair of forceps, and removing it piece-meal, starting from the trephine circle.)

General congestion and injection of the vessels of the dura mater, the site of inoculation being marked out by an area of bloody lymph, roughly corresponding in size and shape to the circle of bone removed from the calvarium. On removing the meninges a thick layer of yellowish lymph is seen adhering to the surface of the convolutions in the left parieto-occipital region (this microscopically consists of a dense mass of large mononuclear leucocytes, permeated throughout by masses of cocci); cerebral vessels greatly engorged and numerous petichial hæmorrhages visible on the surface of the brain.

The cerebro-spinal fluid is more or less increased in amount and contains numerous micrococci, free and also included in cells.

On section there are numerous small hæmorrhages scattered throughout the brain substance, whilst the *velum interpositum* is so congested as to resemble a clot of blood. Elsewhere the brain appears unaffected to the naked eye. Agar tubes inoculated with brain substance from any portion of cerebrum or cerebellum or from cerebro-spinal fluid, either cerebral or spinal, yield a copious and pure growth of *M. melitensis* within 36 hours.

Thoracic Cavity.—Slight enlargement of anterior mediastinal and of bronchial glands. Small quantity of clear serous effusion in the pleural cavity. Cultivations from this fluid remain sterile. Few hæmorrhages on the surface of lungs. Pericardium distended with clear serous fluid, also sterile. Blood removed from right side of heart plated in agar yields, on an average, some 35 colonies per cubic millimetre.

Peritoneal Cavity.—Excess of clear blood-stained fluid in peritoneal cavity, sterile on cultivation. Gall-bladder distended with clear bile. Liver, spleen, kidneys dark and engorged with blood, the spleen being distinctly enlarged.

Cultivations from liver and spleen give good growth of *M. melitensis* within 48 hours. Kidney pulp yields only a few scattered colonies of *M. melitensis.*

Omentum injected; a few enlarged mesenteric glands noted.

Bladder distended with turbid urine. Cultivations prepared from the centrifugalised deposit of the few cubic centimetres of urine contained in the bladder remain sterile.

Cultivations from the bone marrow from practically all the long bones yield a more luxuriant growth of *M. melitensis* than from other organs, with perhaps the exception of the spleen and brain.

Chronic Infection.—As in the present instance we are not particularly concerned with chronic infection, I shall dismiss this subject very briefly.

After intracerebral inoculation with a very minute dose of a highly virulent culture or a fair sized dose of a less pathogenic one the infection pursues an extremely chronic course, and beyond progressive emaciation and profound anæmia presents no very marked or characteristic symptoms. The early symptoms resemble those of the more acute infection above described but are much less severe in character. For instance the incubation period is usually prolonged to two or three days and is followed by a period, extending over from three to six days, during which the animal is distinctly ill and refuses its food, remains huddled up in one corner of its cage, loses weight rapidly and becomes extremely weak. Convulsions of a mild type can usually be provoked at the beginning of this stage by handling the animal or by turning it on to its back.

The animal then gradually recovers, eats well—even ravenously—and although the emaciation may be arrested for a while, the original weight is never entirely recovered. After an interval extending over weeks or even months, during which, except for emaciation, the animal appears in perfect health, death suddenly takes place.

More rarely the animal is obviously ill for two or three days before death, refuses food and becomes comatose just before the end.

Post-mortem Appearances.

Seat of Inoculation.—The site of the skin incision is occupied by a firm linear scar usually adherent to the periosteum and bone beneath, the disc of bone, if it has been replaced, has usually united completely.

Cranial Cavity.—Slight injection of meningeal and cerebral vessels usually present—brain substance appears normal.

Cultures from brain substance and cerebro-spinal fluid yield only a scanty growth of *M. melitensis* or remain sterile.

Thoracic Cavity.—Lungs usually anæmic, otherwise normal; cultures from heart blood remain sterile.

Peritoneal Cavity.—Peritoneum and intestines blanched and anæmic; no subperitoneal, omental or mesenteric fat visible; otherwise viscera normal. Cultivations from liver remain sterile; those from spleen and bone marrow may or may not yield a scanty growth; on the other hand those established from the centrifugalised deposit of the turbid urine or even from the urine itself give rise to fairly good growth.

Mode of Exit of M. melitensis *from the Body.*

A matter of the highest practical importance, but one upon which I have not yet touched, deals with the route or routes by which *M. melitensis* leaves the animal body. So far as concerns what we have termed "chronic" infections, *M. melitensis* can be readily isolated from catheter specimens of the urine throughout the course of the infection and also from urine taken directly from the bladder *post-*

mortem, even when intervals measured by months have elapsed since the inoculation, and no matter what the path of the original infection of the animal has been—intraperitoneal, subcutaneous, or intracranial. This was shown first by Durham, and his results, so far as concerns the guinea-pig and rabbit, have subsequently been as fully confirmed by the observations of other workers as by my own experiments; Horrocks and Shaw have recorded analogous results, too, from observations upon the human subject.

When, however, we consider the results of observations upon the *acute* infections, we find that *M. melitensis* is not consistently present in the urine. In about 50 per cent. of the animals dying within five days of inoculation, I have failed to detect the Micrococcus in the urine, although I have employed the entire contents of the bladder for the insemmination of culture tubes and plates.

During the experiments detailed above, which had for their primary object the exaltation of virulence, I systematically examined many of the organs of the infected animals by cultural tests, using a special circular loop of 1·5 mm. diameter, and carefully compared the amount of the resulting growths.

My observations soon convinced me that the most copious growth per loopful of material was obtained from the brain substance, next in order and all about equal came the liver, spleen, and long bone marrow. Finding such large numbers of cocci present in the liver tissue, I naturally turned my attention to the contents of the gall bladder. In my first observations I seared the surface of the gall bladder with a red hot iron at some convenient spot, punctured the wall with a Pasteur pipette, and aspirated some of the bile in order to prepare my cultivations.

My results were unsatisfactory and inconsistent—sometimes a good growth of *M. melitensis* was obtained, at others the cultures remained sterile. My positive results, I noticed, were obtained when the cultures were made immediately after death; usually, when the *post-mortem* examination was not performed until some hours after death, a negative result was recorded.

It was next observed that if the cadaver was allowed to remain undisturbed, sedimentation occurred in the bile, and the cocci became collected into large flocculent masses deposited near the mouth of the common bile duct, so that if cultivations were made from the supernatant bile no growth resulted, although good growth could be obtained from the before-mentioned flocculent masses when these were taken up by the pipette in aspirating the last portion of bile.

Following the course of the bile, in my subsequent *post-mortem* examinations I prepared plate cultivations (using the modified Drigalaki and Conradi "nutrose" medium that I have already described in connection with some dysentery investigations) from

Table II.—Intracerebral Passages to Exalt Virulence.

Guinea-pig. No. in series.	Sex.	Weight in grammes.	Dose of inoculum.		Bulk of inoculum.	Duration of infection.	Weight at death, in grammes.	Observed loss of weight.	
			In loopfuls.	In milligrammes.				Total in grammes.	Percentage of body weight.
1	♂	380	75	37·5	0·4	25 days	160	220	78·5
2	♀	420	25	12·5	0·3	15 "	150	270	64·2
3	♂	460	25	12·5	0·2	7 "	250	210	45·6
4	♂	700	25	12·5	0·3	9 "	350	350	50
5	♀	750	25	12·5	0·2	2½ "	620	130	17·3
6	♀	480	25	12·5	0·2	2½ "			
7	♂	560	25	12·5	0·2	2 "			
8	♀	560	12	6	0·3	2 "	450	110	19·6
9	♂	890	12	6	0·3	3 "	710	180	20·2
10	♂	570	12	6	0·2	3½ "	460	110	19·3
11	♂	370	6	3	0·2	2 "	270	100	27
12	♂	310	1	0·5	0·2	4½ "	200	110	35·4
13	♂	240	12	6	0·2	2½ "	210	130	54·1
14	♂	240	15	7·5	0·2	4 "	210	130	54·1
15	♀	240	5	2·5	0·1	24 hours	200	40	16·6
16	♀	240	8	4	0·2	2 days	165	75	31·2
17	♂	180	6	3	0·2	2 "	150	30	16·6
18	♂	350	6	3	0·2	2½ "	320	30	8·5
19	♂	450	4	2	0·2	3 "	280	170	37·7
20	♀	250	*	*	*	21 hours	210	40	16
21	♀	380	2	1	0·1	3½ days	270	110	28·9
22	♀	590	2	1	0·3	24 hours	460	130	22
23	♂	350	0·5	0·25	0·1	5 days	230	120	34·2
24	♂	460	0·5	0·25	0·1	2 "	360	100	21·7
25	♀	430	0·5	0·25	0·1	3 "	320	110	25·5

* Owing to error, no note was made of the size of the dose.

Table III.—*Post-mortem* Findings.

Guinea-pig. No. in Series.	*Micrococcus melitensis* recovered in culture from—																
	Brain substance.	Heart blood.	Serous effusion in thorax.	Spleen.	Liver.	Bile.	Peritoneal fluid.	Kidney.	Urine.	Long bone marrow.	Duodenum.	Jejunum.	Ilium.	Cæcum.	Rectum.	Fæces.	Intestinal mucus.
1	±	−		±				±	+								
2	+	−		±				±	+								
3	+	±		+				+	+								
4	+	+		+				+	+								
5	+	+		+				+	+	+							
6				+				−	+	+							
7	+	−		+				−	−	+							
8	+	+		+	+			+	+	+							
9	+	+	−	+	+			+	−	+							
10	−	+		+	+			−	−	+							
11	+	+		+	+	+		±	−	+							
12	+	+		+	+	+	−	+	−	+							
13	+	+		+	+	+		+	−	+							
14	+	+		+	+	−		+	−	+							
15	+	+		+	+	+		+	−	+							
16	+	+		+	+	−		0	0	0	+						
17	+	+		+	+	+		0	0	0	+	−	−	−	−	−	−
18	+	+		+	+	−		0	0	0	+	+	−	−	±	−	0
19	+	+	−	+	+	+	−	±	−	+	+	+	+	−	0	±	0
20	+	+		+	+	+		+	−	0	+	+	+	+	+	0	+
21	+	+		+	+	+		+	+	0	+	0	+	0	0	+	+
22	+	+		0	+	+		−	−	0	+	0	0	0	+	+	0
23	+	+		+	+	+		±	+	0	+	0	0	0	0	±	0
24	+	+		+	0	±		−	−					+	0	+	+
25	+	+		+	+	+		−	−					+			

+ = growth of *M. melitensis*. ± = scanty growth of *M. melitensis*. − = no growth of *M. melitensis*. 0 = not examined.

scrapings from the walls of the bile duct, and from the mucous membrane lining of the duodenum, and had no difficuly in demonstrating the presence of fair numbers of the Micrococci in both these situations. Proceeding onwards along the intestinal canal, positive results were obtained from the upper portions of the jejunum, but owing to the enormous numbers of purely intestinal bacteria which rapidly overgrew the plates, I was at first unable to demonstrate *M. melitensis* in the lower portion of the jejunum, the ileum, cæcum or rectum.

With the death, however, of Guinea-pig 20 (*vide* Table II) within 24 hours of inoculation, a positive result was obtained from each of these situations, although as the rectum was empty no observations could be carried out with regard to the characteristic fæcal masses.

Guinea-pig 21 (*vide* Table II) was deposited in a sterilised glass dish whilst in a moribund condition, so that when the contents of the rectum were expelled at death an hour later, it became a simple matter to prepare plate cultivations from intestinal mucus and fæces separately.

From the mucus a fair number of Micrococci was isolated; the fæcal masses gave considerably more trouble on account of the numerous members of the coli and streptococcus groups that were present, but eventually several colonies were isolated and completely identified with *M. melitensis*.

As will be seen from the details of the *post-mortem* examinations (Table III), these results were confirmed more than once.

From the results of these experiments, therefore, the assumption is justified that *M. melitensis* leaves the body of experimental animals by way of the intestinal tract, and possibly by way of the urinary tract also, when the infection is of the acute type. That the coccus leaves the body by way of the urinary tract *alone* when the infection is of a more chronic character appears probable also, for not only have I not succeeded in isolating it from the alimentary canal or fæces of such animals, but cultivations from liver and bile have always yielded negative results.

Conclusions.

1. By a series of intracerebral inoculations, comprising rapid passages from guinea-pig to guinea-pig, the virulence of *M. melitensis* can be exalted to a high pitch for this particular animal.

2. The virulence finally obtained in the present series is such that a small and accurately measurable dose of cultivation corresponding to about 0·25 milligramme in weight, or to rather more than 6,000,000 cocci, will consistently cause death in about five days.

3. Experimental observations show that in these acute infections *M. melitensis* leaves the body of the inoculated animal by way of the alimentary canal, in the intestinal mucus and the fæces, as well as occasionally by way of the urinary tract (in the urine).

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REPORTS

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COMMISSION FOR THE INVESTIGATION OF MEDITERRANEAN FEVER.

Part I.

Containing Reports by

Major Horrocks, R.A.M.C., Staff-Surgeons Gilmour and Shaw, R.N., and Dr. Zammit.